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CENTRAL AFRICA.

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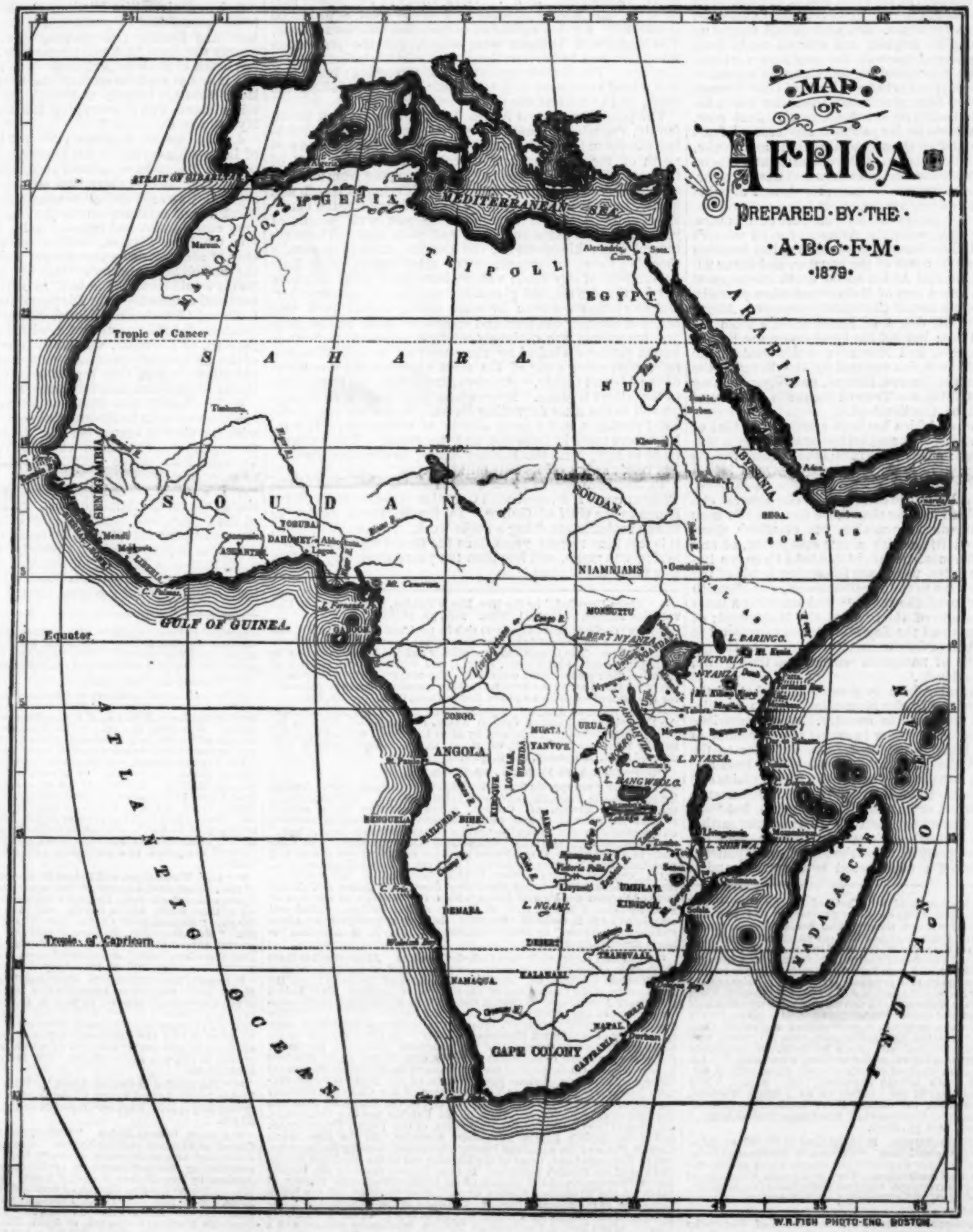
"IN the nineteenth century the white has made a man out of the black; in the twentieth century Europe will make a world out of Africa." The French periodical which quotes this saying of "one of the great poets of the world" has accounts of enterprises innumerable, scientific, commercial, and religious, which are working toward the fulfillment of the poet's prediction. "The African question," it declares, "preoccupies all minds, and the Central Plateau might be compared to a vast citadel assailed on every side by armies of merchants eager to know the riches it contains."[1] We are best acquainted with what England is doing; but Germany, France, Belgium, Portugal, Italy, all have their parties of scientific explorers penetrating the vast unknown; while commercial companies are organizing for manufacing, for traffic, and for communication by canals, railroads, telegraph lines, steamboats, and elephant trains. The flooding of the Sahara may seem chimerical; to make an inland sea over which transit shall be swifter than by camels, while by the evaporation of its waters the shores shall be made fertile and fruitful in harvests. But the French Government looks favorably upon the railway from Algeria toward the Soudan, and four other railroads to the interior are projected.[2]

With towns hidden in the mysterious depths like Sansandig, of only 40,000 inhabitants, but which has "merchants who could at a moment's notice produce $250,000 or $300,000 more readily than many European bankers;" with cities like Kuka, of 60,000 inhabitants; Bida, Abeokuta, and Illora, of 80,000, and Ibadan, of 150,000;[3] with exports from the single port of Lagos of two and a half million dollars,[4] paid for in the products of English looms and anvils, it is not strange that keen-eyed Commerce should be looking into this "dark continent." Seven hundred thousand kilogrammes, a million and a half pounds, of ivory, are annually received in England, it is stated,[5] to yield which 50,000 elephants must be slain—some inroad this must make upon the monsters of which Livingstone saw troops two miles long[6]—cotton to be obtained, coffee, camwood, indigo, gold, iron, copper, coal, palm oil, India rubber, beeswax, ground nuts, a fresh market for what is yielded by her whirling spindles



[1] *L'Afrique Explorée et Civilisée*, Journal Mensual, Prem. Ann., 1879–1880. Genève et Paris, 1879. No. 1, July, 1879, pp. 3, 18.

[2] For exploring expeditions now in progress and commercial companies, see *L'Afrique*, No. 1, pp. 7–15, 18, 19, 21, 22, and No. 2, August, pp. 25–28, 34–38, September, pp. 48, 49. "Proceedings of the Royal Geographical Society," London, 1879; for February, pp. 128 *seq.*; for May, pp. 323 *seq.*; for June, pp. 358, 362 *seq.*; for August, pp. 312 *seq.*; for September, pp. 569, 591.

[3] Rohlf, in Stanford's "Compendium of Geog. and Travel," "Africa," edited and extended by Keith Johnston, London, 1878, pp. 153, 154, 163, 181. A minute description of Kuka, the life and business, trades and occupations, and amusements of the people, is given in "Sahara und Soudan Ergebnisse sechsjährige Reisen in Afrika," von Dr. Gustav Nachtigal, Erster Theil, mit neun und vierzig Holtzschnitten und zwei Karten. Berlin, 1879 (June). Imp. 8vo, pp. 768. Book II., chs. 5 to 10, pp. 581–784.

[4] *Journal Society of Arts*, June 13, 1879, p. 645. In 1875, English produce, imported at Lagos, was valued at £459,787, African produce exported, £517,586, a total of £977,273 = $4,590,000. In 1876 the trade in India-rubber on the East Coast reached $500,000. Stevenson, "Civilisation of Southeastern Africa," Glasgow, 1877.

[5] *L'Afrique Explorée*, p. 17. "Livingstone's Last Journals," vol. ii., pp. 89 *et seq.* "The Last Journals of David Livingstone in Central Africa," from 1865 to his death, continued by a narrative of his last moments and sufferings, obtained from his faithful servants, Chuma and Susi, by Horace Waller, F.R.G.S., Rector of Twywell, Northampton, 1874, 2 vols., 8vo.

[6] "Expedition to the Zambesi," ch. 6.

and her skillful fingers; it would be strange if Europe did not try to make a world out of Africa.

In the making, Christianity must have a hand or there will be a failure. Christianity has made the beginning. This inroad upon the Central Plateau is through the gates which Christian missions have opened. The movement toward scientific exploration of the recesses of Africa and all that is coming out of it, originated in what was done by self denying ministers of the Church Missionary Society, who do not yet rest from their labors, though their works do follow them.[7]

I.—THE COUNTRY IN GENERAL.

The continent of Africa is equal in area to Europe and North America combined, and has a population more than double that of both Americas; it holds nearly one-sixth of the human race.[8] The northern portion was the seat of ancient civilization, and has had its part to play in the modern world. South Africa for more than two hundred years has been the seat of European colonies, which are now becoming opulent free states. Central Africa has been almost an unknown region till our day. Snow-capped mountains may be seen from far; but Kilimanjaro and Kenia, though only two hundred miles from the eastern coast, had not been seen by European eyes till 1848; and the story of missionaries about the great inland seas was laughed at in geographical circles twenty-five years ago.

To many the marvelous volumes of Mr. Stanley first disclosed the mysteries of "The Dark Continent;" dark in our knowledge of it and in its moral coloring, though in its physical characteristics comparable with the fairest quarters of the globe. Mr. Stanley, in his great feat of crossing from east to west, was preceded a year by Commander Cameron, who went through lower down. Dr. Livingstone ranged up from the Cape Colony to Angola, and crossed again from west to east and zigzagged through the southern portions. Dr. Lacerda, in 1798, penetrated to the Cazembe's capitol, as did Monteiro in 1831; the Portuguese knew of Lake Nyassa; Graça and Silva Porto have penetrated from the west; Savorgnan de Brazza has explored the Ogowè. Just now, Major Alexander Alberto de Serpa Pinto has crossed from the Atlantic to the Indian Ocean; while Grant and Speke, Gordon, Elton, Van der Decken, Schweinfurth, and others, have made great discoveries in the eastern and northern portions. Yet much remains wholly unexplored, and of what we know best our knowledge is imperfect.[9]

Central Africa geographers call all that part of this mysterious continent which, with the Atlantic for its western boundary and the Indian Ocean for its eastern, lies between the parallels of about 5° north of the equator, and 18° or 20° south.[10] Bordering Central Africa on the north are the great states of Soudan, where a sort of Mohammedanism prevails, and Abyssinia, where a sort of Christianity prevails. Above these the Sahara and the desert of Nubia stretch from the Atlantic to the Red Sea; beyond the great desert are Egypt, Tripoli, Tunis, Algiers, and Morocco; while west of the Soudan are the vast territories watered by the Senegal, the Gambia, the Jolliba, the Quorra, Binnuè, and Niger, coming down to the Gulf of Guinea. Toward the south, the central plateau is bounded by the Zambesi.

The shape of Central Africa has been compared to that of an inverted saucer. It is rimmed on the seacoast by a narrow strip of low land; a few miles inland the country rounds up to a rocky ridge; a little further in, it spreads into a table-land, which, sinking into a slight hollow toward the middle, fills the breadth of the continent. The general elevation of the table-land is more than 2,500 feet,[11] while here and there it is swollen into mountains, out of which shoot peaks which are the loftiest, with a few exceptions, of any on the globe. In the most elevated table-land there are immense swamps and lakes, which are the spring heads of the Nile, flowing northward to the Mediterranean, one-eleventh of the circumference of the globe,[12] and draining a basin more than twice the size of the basin of the Mississippi; of the Jub and the Dana and the Zambesi, flowing eastward to the Indian Ocean; and of the Cunene, the Coanza, the Congo, with its 4,000 miles of navigable waters, and the Ogowè, emptying into the Atlantic.

The area of Central Africa is greater than that of the United States east of the Rocky Mountains, and its population is about equal to our whole country. A characteristic feature is a chain of lakes, vaster in extent and in volume of water than those which stretch from Lake Superior to the St. Lawrence.[13] While there are interminable forests and morasses, there are still greater breadths of fertile plains and salubrious high lands. Central Africa is not, as it was once thought, a torrid desert or an unmitigated swamp, but "one of the most luxuriant and productive regions of the earth." "It is imagined by some," continues Mr. Rowley, who has traversed the eastern portion, "that the great central plateau, because it is the seat of a wide-spread lake system, and is also intersected in almost every direction by rivers which have numerous branches, and in whose valleys marshes are formed, is nothing better than a huge swamp. This is an error to which travelers have unwittingly contributed. Most African explorers have had for their object the discovery of river sources. Travelers, therefore, have kept as close as they could to rivers, and in the narratives of their travels they frequently describe a very humid country. Livingstone was said by the natives to have been afflicted with water in the head, so persistently did he hunt after and cling to the watery regions. But no one knew better than Livingstone that the swamp lands are not the chief characteristic of Central Africa. He continually expatiated on magnificent ranges of highland country. My recollections of the highlands of East Central Africa are not less pleasant than were those of Dr. Livingstone. After leaving the river Shirè, at about 350 miles from the coast, and passing over a hill country in which steppes alternated with broad valleys, cultivated lands with long stretches of park-like woods, we reached, at an altitude of about 2,500 feet, a seemingly illimitable plain, which opened out to view one of the most magnificent prospects I ever beheld. Far as the eye could see—and here for the greater part of the year, the atmosphere is so clear that it does not seem to impede the vision—there extended a wide, grassy plain, broken here and there by rocks of fantastic shape, verdant hills, clusters of trees, streams of water on whose banks grew lofty trees, which formed bowers of foliage that equaled in hue and excelled in grace of form any similar production of Europe; and mountains that far and near lifted up their heads toward the pale azure of the sky, rising sometimes to the height of nearly 10,000 feet. . . . The fertility of the greater part of this plain was remarkable. Year by year it produced abundantly a great variety of cereals and tuberous plants. The larger wild animals were scarce, for the population was great, and had driven them to take shelter in less peopled districts. The climate was cool and refreshing; indeed, it was a land calculated to nourish the body, to gladden the heart, and to content the mind."[14]

The people of Central Africa belong to the great Bantu family, resembling somewhat in color and form, but differing wholly in language from the negroes proper, who dwell north of the Equator, and especially about the Gulf of Guinea. The Bantu tribes have a skin varying from a brown to a blue-black, and hair woolly, but differing in length and quality. In the far interior are tribes of dwarfs, the classical pygmies,[15] Major de Serpa Pinto met with people of yellowish-white skins and hair, and pink eyes. There are several large kingdoms in the interior, though generally there is a loose, incoherent, tribal relationship, with little government of any kind; villages have head men, and look out for themselves, but give little support to one another. Cotton cloths are woven by some tribes; smiths melt iron ore, and hammer out hoes and spears on stone anvils; copper ornaments are curiously wrought; earthen pottery in basket patterns is baked by the women. A belt of cannibals, comprising some of the most vigorous and intelligent of the African people,[16] stretches across from the Cameroons to the Albert Nyanza. Everywhere polygamy and slavery prevail in the most degrading forms. Slaves are one of the chief products, and a great article of commerce. The inland slave trade is immense and universal. The external trade to Egypt and the Barbary States, Arabia, and Turkey, has yearly swept off its half million souls.[17]

In Northern Africa Mohammedanism is prevalent. The western coast is fringed with Christian missions from Sierra Leone to the Gulf of Guinea. In South Africa twelve or fifteen societies are doing a noble work. As for the interior, it is less than twenty years since the first Protestant undertaking was made, and less than ten years since any society was fairly established.[18]

II.—ORGANIZATIONS NOW AT WORK IN CENTRAL AFRICA.

We cannot know what we ought to do until we know what others are doing.

Upon this immense plateau of heathenism, with its seething swamps and morasses and icy peaks and its fertile plains and breezy uplands, there are at the present time ten Christian organizations at work. On an equal division, each society would have a parish of sixty thousand square miles and of four million souls.

1. The Church Missionary Society of England, thirty-five years ago, led the way for all that has come and is coming, by planting a mission at Mombasa, on the Indian Ocean, near Zanzibar. Mombasa is not inland, but it has proved in God's providence the first step thitherward. Three years ago this venerable society struck inland seven or eight hundred miles to Victoria Nyanza, and began a mission in Uganda and Karagua, with stations at Mpwapwa and elsewhere, intermediate from the coast. This region is in the extreme northern part of Central Africa, and is of vast magnitude. The Victoria Nyanza covers an area equal to the great State of New York, and its shores and beautiful islands are alive with busy populations. Mr. Stanley says King Mtesa had a navy of three hundred war canoes, and an army of one hundred and fifty thousand warriors.[19] Great difficulties are encountered in the mission, great sacrifices of precious lives, and large expenditures of treasure have been made; but the latest intelligence is full of promise.[20]

2. The United Methodist free churches of England have had a mission since 1862, at Ribe, near Mombasa, a few miles from the ocean, and about one hundred and fifty miles south of the Dana river.[21]

3. The Universities Mission, the first mission in the interior, established by gentlemen of Oxford, Cambridge, Durham, and Dublin Universities, was commenced in 1860, among the Shirè highlands, near lake Nyassa, and after the sad death of Bishop McKenzie was removed to Zanzibar, and now has stations on that island, at Magila, on the mainland, two days inland, at Masasi, one hundred and thirty miles inland, and is occupying the territory between Lake Nyassa and the ocean.[22]

4. The London Missionary Society has taken the region of Lake Tanganyika, seven hundred miles by road from the ocean. It is to have stations at Mirambo's town in Ugara, at Ujiji on the east shore, and elsewhere on the lake. The region is immense and of commanding importance on the great line of caravans across the continent. It is proving very costly in life and treasure to lay the foundations.[23]

5. On Lake Nyassa, farther south, and comparatively easy of access, with water deeper and wilder than that of any Scotch tarn, and mountains by the side of which Ben Nevis would seem an ant-hill, in 1872, the Free Church of Scotland commenced the Livingstonia Mission, and the Established Church a mission at Blantyre near by. So momentous did the question of a wise location seem that Dr. Stewart, of Lovedale, was taken from his important charge of the college and spent months in making inquiries and explorations before this region was decided upon, though David Livingstone himself had recommended it.[24]

6. The Société des Missions Evangéliques, of Paris, in conjunction with its Basuto churches, has made explorations with the view of occupying the Barotsè Valley, which is the region about the head waters of the Zambesi, above the Victoria Falls, some 1,200 miles from the mouth of the river.[25]

7. The Livingstone Inland Mission has had missionaries since 1878 on the Atlantic coast, working about the mouth of the Congo, and measures are in progress to reënforce them and push into the region north of Stanley Pool.[26]

8. The Baptist Missionary Society of England has a station at Makuta near the Congo, south of the Yellala Cataracts, and is endeavoring to reach Stanley Pool and work upward on the south side of the great river.[27]

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[7] Captain Speke, in his work entitled "What Led to the Discovery of the Sources of the Nile," states that on his return from a journey to the Somali Land, on visiting the Royal Geographical Society, there was revealed to him for the first time the great object of an expedition planned by Captain Burton. "On the walls of the Society's rooms there hung a large diagram, comprising a section of Eastern Africa, extending from the equator to 14° south latitude, and from Zanzibar sixteen degrees inland, which had been constructed by two reverend gentlemen, missionaries of the Church Missionary Society of London, a short time previously, when carrying on their duties at Zanzibar. In this section map, up about half the whole area of the ground included in it, there figured a lake of such portentous size and such unseemly shape, representing a gigantic slug, or, perhaps, even closer still, the ugly salamander, that everybody who looked at in incredulously laughed and shook his head. It was indeed phenomenon enough in these days to excite anybody's curiosity!" Edward Hutchinson, Esq., in *Journal Society of Arts*, June, 1876, p. 691. D'Anvers, "Heroes of South African Discovery," 142. Speke, "Nile Sources," 204. "Proceedings of the Conference on Foreign Missions, held at the Conference Hall, in Mildmay Park, London," in October, 1878; the admirable paper on "Discovery and Missions in Central Africa," by Sir T. Fowell Buxton, Bart, pp. 35–49.

[8] 12,000,000 sq. m. 186,000,000 pop. Banning gives 18,000,000 sq. miles as the area, and 200,000,000 population. "Africa and the Brussels Geog. Conf.," pp. x. 83. In this paper we give round numbers and usually the lowest figures of the best authorities. They are rough estimates, of course, but approximate correctness. Stanford's admirable Compendium, "Africa," by Keith Johnson, unfortunately does not furnish as many statistics as we look for.

[9] For an admirably compact and comprehensive sketch of discoveries in Africa in the nineteenth century, see Banning, "Africa and the Brussels Geog. Conf.," ch. 1. *Revue de Géographie*, Paris, Institut Géographique de Paris, July, 1879: "Les Anciennes Explorations et les Futures Découvertes de l'Afrique Central," by E. T. Berlioux. On the discovery of the Snow-capped Mountains: Krapf's "Travels," Appendix. p. 348 *seq*.

[10] This is the definition of Central Africa, given at the International Geographical Conference at Brussels, September, 1876. "History," by E. Banning. London, 1877, pp. xii., and Appendix, 183.

[11] The surface of Victoria Nyanza is 3,700 feet above the ocean; of Tanganyika, 2,700 feet.—Banning, "Bruss. Geog. Conf.," 40.

[12] H. M. Stanley makes the Nile 4,200 miles long. "Through the Dark Continent," vol. i., p. 158. The usual estimate is about 2,300 miles.

[13] The Victoria Nyanza measures, Banning says, 40,000 square miles. Tanganyika is 400 miles long, and covers 22,500 square miles. Nyassa is 200 miles long, and covers 8,000 square miles.—Banning, ch. 2. Stanley gives 21,500 square miles as the area of Victoria Nyanza.

[14] "Africa Unveiled," by the Rev. Henry Rowley, formerly of the Universities' Mission to Central Africa. 1876, pp. 11. 12.

Banning declares that Africa "is rich in products of every kind, and possesses in abundance all the resources which form the material basis of civilization. The populations are neither unfitted for nor opposed to all improvement. Christianity, science, and commerce are capable of changing their whole social condition. The advances which they have already realized under the least favorable circumstances are a guarantee for the future."—"Africa and the Bruss. Geog. Conf., pp. 101, 102.

[15] "The Heart of Africa." "Three Years' Travels and Adventures in the Unexplored Regions of Central Africa, from 1868 to 1871," by Dr. George Schweinfurth. Translated by Ellen E. Frewer, with an Introduction by Winwood Reade, 1873, vol. ii., ch. 16. "Through the Dark Continent," by H. M. Stanley, vol. ii., p. 172.

[16] Schweinfurth, ch. 15, vol. ii., pp. 92 *seq*.

[17] Banning gives specific figures for "400,000 persons at least. According to Sir Bartle Frere, this minimum is far exceeded. The Superior of the Catholic Mission of Central Africa estimates at a million of men the amount of loss which the slave trade inflicts annually on the populations of Africa."—"Africa and the Brussels Geog. Conf.," ch. iv., pp. 94 *seq*., specially. Commander Cameron says: "The slave trade in Africa causes, at the lowest estimate, an annual loss of over half a million lives."—"Across Africa," by Verney Lovet Cameron, C.B., D.C.L., Commander Royal Navy, Gold Medallist R.G.S., 1877, vol. ii., p. 336. See, also, "Travels and Researches among the Lakes and Mountains of Eastern and Central Africa," from the journals of the late J. Frederic Elton, F.R.G.S., H. B. M. Consul at Mozambique, edited and completed by N. B. Cotterill. 8vo, 1879 Introductory chapter on "Africa and the Slave Trade," by Frederic Holmwood, Esq., H. M. Assistant Political Agent at Zanzibar.

[18] In Algeria there are Roman Catholic Missions. At the Gambia there are stations of the Wesleyan Methodist Society and of the Paris Société des Missions Evangélique. At the Pongas, those of the Society for the Propagation of the Gospel, and of the Church of England West Indian Missionary Association. At Sierra Leone, those of the Wesleyn Missionary Society, of Lady Huntingdon's Connection, and of the United Methodist Free Churches. At Mendi, those of the American Missionary Association, and of the Church Missionary Society. At Liberia, those of the American Protestant Episcopal, of the American Methodist Episcopal, and of the American Presbyterian Societies, and of the Basle Missions Evangéliques. On the Gulf of Guinea, those of the Wesleyan Missionary Society, of the Basle Missions Evangéliques, of the North German (Bremen) Missions Gemeinde. At Yoruba, those of the Church Missionary Society, of the Wesleyan Missionary Society, of the American Southern Baptist Convention. On the Niger, at old Calabar and the Cameroons, are those of the Church Missionary Society, of the United Presbyterian, and of the English Baptist Missionary Societies. At the Gaboon and Corisco, those of the American Presbyterian Board. Among the Damaras, and in Namaqua Land, those of the Rhenish and of the Wesleyan Methodist and of the Finnish Societies. In Cape Colony, those of the Society for the Propagation of the Gospel, of the London Missionary Society, of the Wesleyan Missionary Society, of the United Brethren, of the Berlin Gemeinde, of the Rhenish (Barmen) Gemeinde, of the Paris Société Evangélique, of the Reformed Church of Cape Colony, of the Scotch Free Church, of the United Presbyterian Foreign Missionary Society, and a Moslem Missionary Society. In the Transvaal, Kaffraria, Natal, and Zululand, those of the London Missionary Society, of the Wesleyan Missionary Society, of the Paris Société des Missions Evangéliques, of the Berlin Missions Gemeinde, of the Hermannsburg Missions Gemeinde, of the Reformed Church of Cape Colony and of Natal, of the Society for the Propagation of the Gospel, of the Scotch Free Church, of the Scotch United Presbyterian, of the United Brethren, of the Norway Missions Gemeinde, of the Swiss of Canton de Vaud, of the American Board, of several independent laborers, and of the Roman Catholics. In Madagascar are those of the Roman Catholics, of the Norway Missions Gemeinde, of the Society for the Propagation of the Gospel, and of the London Missionary Society. In Abyssinia, those of the London Jewish Missionary Society, of the Established Church of Scotland Jewish Mission of the St. Chrischona Pilgrim Mission, of the Swedish Evangel. Fosterlands Stifels, and of the Roman Catholics. In Egypt, those of the Roman Catholics, of the American United Presbyterian, of the St. Chrischona Pilgrim Mission, and of several independent laborers. About 1860 the St. Chrischona brethren projected an "Apostles' Street," to reach from Egypt southward; to be comprised in twelve stations, fifty leagues distant from each other—St. Matthew's Station to be at Alexandria, St. Mark's at Cairo, St. Luke's at Assuan, and thus onward. The "Apostles' Street" has not been completed, and the project never had much success. See Krapf, 133.

[19] "Through the Dark Continent," vol. i., ch. 12.

[20] For an interesting history of this mission, and the preparatory work, see "The Victoria Nyanza, a Field for Missionary Enterprise," by Edward Hutchinson, F.R.G.S., F.S.A., author of "The Slave Trade of East Africa," 1876, 8vo., pp. 136. "The Victoria Nyanza Mission," a brief account of the Church Missionary Society's Mission to Central Africa, with extracts from the missionaries' letter, and a new map, pp. 60 (1878). "The Lost Continent, its Discovery and Recovery; or, Africa and the Church Missionary Society," by Edward Hutchinson, F.R.G.S., etc., etc., 8vo, pp 72, 1879. "Eastern Africa as a Field for Missionary Labor." Four letters to His Grace the Archbishop of Canterbury, by Rt. Hon. Sir Bartle Frere, G.C.S.I., K.C.B., D.C.L., etc., with a map, 1874, 8vo, pp. 122. Second letter. The expenses of this mission, commenced in 1876, are reported to March, 1876, £849; to March, 1877, £9,069; to March, 1878, £7,078; to March, 1879, £13,839. Total, £30,830 = $154,000. March, 1879, the staff comprised two clergymen and seven lay teachers, with two stations.

[21] "Life, Wanderings, and Labors in Eastern Africa," with an account of the first successful ascent of the equatorial Snow Mountain, Kilima Njaro, and remarks upon East African slavery, by Charles New [missionary at Ribe, where he lies buried], with map and illustrations, 1874, 8vo, 530 pp. "Memorials of Charles New," by S. S. Barton, 1876, 12mo, pp. 290. "Memoirs of Mrs. Rebecca Wakefield," by R. Brown. "Twenty-second Annual Report of Home and Foreign Missions, United Methodist Free Churches," 1878. *Magazine* of same for July, 1878. Expenses for year ending June, 1878, £1,808. Four (?) missionaries.

[22] Reports from 1870 to 1879. Occasional Papers, Nos. 4, 6, 7, 8, 9, 10, to March, 1879. Reports for Parochial Use, 1865 to 1873. "The Early Years of the Universities' Mission, by Rev. H. Rowley. "The Work of Christ in Central Africa," by Rev. J. P. Farler, 2d ed., 1878. Bishop Steere's Account of Zanzibar. Sir Bartle Frere's "Eastern Africa," pp. 24–47. At the close of 1878 the European staff numbered one bishop, six priests, six deacons, and twelve laity, six of whom were women. Amount expended in 1878 was £4,520 19s. 9d. The average for the five last years is about £3,425.

[23] "The Mission in Central Africa." With map. March, 1879. "The Eighty-fourth Annual Report of the London Missionary Society, for year ending May 1, 1879. Expenses reported to May, 1877, £3,584; to May, 1878, £4,046.

[24] Eastern Central Africa. "Livingstonia: The Mission of the Free Church of Scotland to Lake Nyassa," 3d edition. 1876, pp. 48. "Nyassa: a Journal of Adventures while exploring Lake Nyassa, Central Africa, and establishing the Settlement of Livingstonia." By E. D. Young, R.N. Revised by Rev. Horace Waller, F.R.G.S. With Maps. 1877, 12mo, pp. 239. "Report [of Free Church of Scotland] on Foreign Missions." With Maps. May. 1879. "African Papers, No. 1, Livingstonia. Edited by James Stewart, M.D., F.R.G.S., 1879, 8vo. pp. 74. The cost of the Livingstonia Mission is reported, to April, 1876 £5,111; 1877, £2,160; 1878, £3,382; 1879, £2,150. Total, £12,806 = $64,000. Staff, one minister, one evangelist, seven artisans. The expenses of the Blantyre Mission are reported to January 7, 1877, £3,548; 1878, £1,226; 1879, £2 115. Total, £6,889 = $34,500. Staff, one minister and wife, one physician, one dairy woman, five artisans.

[25] The *Journal des Missions Evangéliques*, from March, 1876, to July, 1879, contains communications from M. Coillard touching the Barotsè Valley. "54me Rapport, Mai," 1879, pp. 29–34.

[26] Livingstone (Congo) Inland Mission. Report of first year's work, 1878 Hon. Secretary, Rev. Alfred Tilly, Cardiff, Wales. 1879, Receipts, £1,266 4s. 11½d. Payments, £987 17s. 3d. Five (? missionaries; two stations. "The Regions Beyond," edited by Mrs. H. Grattan Guinness; number for March, 1879.

[27] *The* (Baptist, English) *Missionary Herald*, 1877 to 1879, contains papers of great interest on this undertaking; also, "Explorations Inland from Mount Cameroons, and through Congo to Mkouta," by Rev. T. J. Comber, February, 1879. Expenses, 1879, £1,300; staff, four missionaries.

9. The Roman Catholics have missions at Zanzibar,[28] at Bagamoyo, at Ujiji, and in Mtesa's kingdom, and on the Congo. A company of priests is also on the way to the Barotse Valley, traversing the immense spaces in wagons from Cape Town.

10. Another organization really Christian, and which may be so helpful to all the missions that it should not be omitted in enumerating the agencies at work for the redemption of Central Africa, is the International Association for the suppression of the Slave Trade and opening of Central Africa. In September, 1876, under the presidency and by the invitation of His Majesty Leopold II., the King of the Belgians, there was held at his palace at Brussels a geographical conference, comprising eminent men of seven great European nations. An organization was formed, with King Leopold as President, and the presidents of the geographical societies of Berlin, Vienna, Paris, and London, as vice-presidents, "to explore scientifically the unknown parts of Central Africa, to facilitate the opening of roads by which civilization may be introduced, and to find means of suppressing the negro slave trade." In pursuance of these objects, the one practical measure determined upon was the formation of relief stations at Bagamoyo on the east, at Loanda on the west coast, at Ujiji, and Nyangwé, and at Muato Yanvo's capital in the interior, and at other commanding centers. The relief stations are to have no military surroundings; they are to comprise a scientific man as chief, with a naturalist, an astronomer, and several artisans skilled in handicraft. The aid of merchants and consuls where such are found is to be invoked. The stations are to be provided with stores of every kind to furnish resting places for travelers, explorers, missionaries, to supply necessaries, and gather information. They are not to be distinctively commercial nor religious. "Missionaries," says the secretary, "will be free to come and establish themselves in the neighborhood, and to erect places of worship and schools; to whatever creed they belong, they will receive aid and support from the relief stations."[29] Expeditions to carry out these great objects have already started. Companies of scientific men have gone in from Zanzibar, and one or two other stations are in process of establishment towards Lake Tanganyika and beyond. Mr. Stanley's expedition to the mouth of the Congo is a part of this scheme. His Majesty, King Leopold, expressed the hope that our Board, in its proposed mission, would find these relief stations helpful, and would also contribute, by what it should do, something to increase the number and usefulness of such relief stations.[30]

In proposing to join forces with these great organizations already at work for the evangelization—the King of the Belgians himself used the word *evangelization*—of the Dark Continent, it would be unpardonable not to seek carefully and avail ourselves eagerly of the information they have gained, the fruits of their explorations, the lessons of their experience, and the counsels they have to offer.

We gladly take this opportunity to express our deep appreciation of the distinguished courtesies and generous favors received in the prosecution of our inquiries from officers and members of these honored societies; from missionaries, explorers, and travelers, and from many other gentlemen in the most eminent stations of the civil, scientific, and social life of Europe, who have manifested a lively interest in our work, and have rendered substantial assistance.[31]

III.—WHERE SHOULD A NEW MISSION BE ESTABLISHED?

In the judgment of those whose advice is of most value, the question of location is of supreme importance. Mistakes involving large expenditures of money and sacrifice of life have been made, by our own board as well as by other societies, and in this very continent of Africa, in entering regions which afterwards had to be abandoned. A missionary society cannot be justified in selecting only a good field if there is a better one accessible; much less can it be justified if it fails to seek all available information as to regions that seem inviting. Nor will it answer, as our experience during the past few weeks teaches, to rely upon the information which is on the surface, or to take up with what may seem at first view most promising fields; prolonged inquiries may prove fields of outward promise to be undesirable, or that others are preferable. To the inquiry, What portion of Central Africa now most needs missionary labors, and offers most encouragement; where we should interfere with no other society, but might best coöperate with all; and where the work is not likely to be done unless we do it, eight regions; to name only those of great importance, have been suggested.

1. The first is that of the Upper Congo.

Mr. Arthington, of Leeds, who, it was understood, proposed to give £3,000 towards a mission in Central Africa, specifically allotted a territory beginning where the Ikalembe flows into the Congo, six or seven hundred miles from its mouth, thence running a thousand miles or so along the river eastward and southward. Nine degrees of longitude and fifteen degrees of latitude comprise this allotment, including an area nearly equal to the United States east of the Mississippi.

It is in favor of it that it is a vast domain, in the very heart of the continent; that here, probably, the darkness is densest and the savagery most unmitigated; that the region has never been trodden by the feet of gospel messengers; and that no other society is likely to enter it.

On the other hand, it must be said that we know almost nothing, and need to verify what knowledge we have of the country and of the people. Mr. Stanley swept down the broad swift current of the Congo, seeing only what a man in a boat could see over banks shrouded in part for leagues by impenetrable forests, or jungles of tall reeds and rushes. Commander Cameron crossed the southern part of this region, and Dr. Livingstone penetrated it here and there. Nyangwé, the largest town on the eastern sweep of the Congo, is the great center for Arab slavers. Of Muato Yanvo's capital, no traveler gives any description. From all accounts, this great island, upland, billowy plateau, has a teeming population of discordant and belligerent tribes, some of them ferocious cannibals. Armed launches may force a passage up and down the river. Some time must elapse before it would be hopeful to establish mission stations. Neither of the missionary societies at work below Stanley Pool counts upon reaching the smooth water above the cataracts in less than a year. Mr. Stanley, with his steam launches and great equipments for ascending the river, is not expected to get through and return in less than two years. Our friends of the Livingstone Inland Congo Mission, and of the Baptist Missionary Society, express the most hearty welcome to our Board, if it will join them, and are ready to coöperate to any extent practicable. Ultimately, of course, these societies would expect to have, and it would be right they should have, the lower Congo for their operations. Inevitably it would be several years before an independent station could be formed by the Board above the Ikalembe, which is the lowest point Mr. Arthington designates. Instead of adding a fourth exploring company to those already at the mouth of the Congo, it seems expedient to wait, and not to interfere with their undertakings.[32]

2. The second region suggested is that of the Dana River and Mt. Kenia.

On the eastern side of Africa, two or three degrees south of the equator, there is a knot of mountains which reach an altitude almost as high as Mt. Blanc would be with Mt. Washington on top of it. Two of these mountains, Kilimanjaro and Kenia, though under the very equator, with the torrid sun blazing square down upon them twelve months of the year, are covered with perpetual snow, and feed great rivers which flow through forests of priceless timber and fertilize fields which only need the peace and security of Christian civilization to be granaries of wealth. These mountains lie east of Victoria Nyanza, towards which they may send their western rain-fall, as that on their eastern flanks discharges at a shorter distance into the Indian Ocean. The region is described by Krapf and Rebmann as the Switzerland of Africa. Mt. Kenia, nearest the equator, gives rise to the Dana River, which rushes in a strong current 200 miles to the ocean. A bar at the mouth blocks the Dana to large ships; inside the bar, a steamer can pass up 100 miles from Formosa Bay.

It is in favor of this region that several gentlemen in missionary and scientific circles, deeply interested in our undertaking, and thoroughly acquainted with African explorations, without previously exchanging a word with each other, spontaneously named this as above all others the region they would recommend to the Board. "The climate is beautiful and healthy." The tribes south of the river are branches of the Wapokomo and Ukambani, not very numerous, but accessible to missionary effort. Mingled with these tribes south of the Dana, and chiefly occupying the region north of it, are the Gallas, a vigorous, dominating race, numbering many millions,[33] and dividing with the Somali the vast territory northward to Abyssinia. The Gallas call themselves "Orma," which means *brave* men. Dr. Krapf, who knows them well, calls them the Germans of Africa, and thinks "they are destined after their conversion to Christianity to fulfill for Africa the mission which heaven has pointed out to the Germans in Europe."[34] The Gallas are not negroes proper; they are classed among the Hamitic families; are "of a dark brown color, powerfully built, more savage looking from their long hair worn like a mane on their shoulders." In the neighborhood of Abyssinia they are Mohammedans, and tillers of the soil; under the equator they are heathen, and lead a nomadic life, as breeders of cattle, immense herds of which feed on the succulent plains watered by the Dana and the Jub.

The approach to this field would be easy. It is not far from Zanzibar to Formosa Bay, where the beautiful islands of Patta and Manda, fertile and healthy, would serve admirably as a base of operations. Dr. Krapf is confident that the Dana River offers a good way of reaching the northern end of Victoria Nyanza, and regards the occupancy of the Dana and Mt. Kenia as opening ultimately to the territory north and west of Albert Nyanza. The Church Missionary Society would most heartily welcome our Board to a field so closely connected with theirs at Mombasa, and at Kilimanjaro, which they hope to occupy, and at Victoria Nyanza, which they are occupying. They kindly offer to place at our disposal what Dr. Krapf, and Rebman, and others of their missionaries have done in preparing dictionaries and grammars, and in making explorations and gathering information.

There are drawbacks to the choice of this field. Attempts have been made to occupy it, which have not succeeded. It has even proved perilous to try to penetrate the country of the Gallas, who are a fierce, if not a ferocious people. Baron Van der Decken was harassed and baffled in his efforts to explore the Dana River, and was slaughtered with nearly all his followers on the Jub, a few years since (1865). The Wapokomo, south of the Dana, are not numerous; they are to be reckoned by thousands only. A mission among the Gallas, however important, will not spread into Central Africa, but rather away from it. These and other drawbacks it may not be necessary to dwell upon in view of another consideration which, perhaps, will of itself be decisive. The United Methodist Free Churches, who have for seventeen years had a mission at Ribe, about 150 miles South of the Dana, say they are fully expecting to push their stations up to the Dana, and to cross it and work among the Gallas.

It was not till special attention had been called to this great field, and inquiries had been pushed in various directions for all the information attainable, that discovery was made on a personal visit to the managers of the Free Methodist Mission that for our Board to choose this region, might seem to interfere with their plans. Though the resources which our Free Methodist friends can devote to this work will not allow them to do what they would like to do and what greatly needs to be done, it was their original intention and has long been their endeavor, to labor among the Gallas. Ribe holds the precious dust of not a few of their sainted brethren and sisters; the mission is endeared to them by the sacrifice it has cost, and they are courageous to believe a brighter future is before them, and a wider territory is to be evangelized by their endeavors.[35]

3. A third region, and a vast one, suggested for the Board, is the region north and west of the Albert Nyanza, among the Monbuttos and the Niam-Niams.

The Church Missionary Society, with its stations on Victoria Nyanza, would cordially welcome us to this neighborhood, and be glad to share with us and have us share with them the labor and expense of developing it. From the accounts of Schweinfurth and of Gordon, this region is extremely populous and wealthy. There seems to be more consolidation of tribes into kingdoms and more advance towards civilization. Schweinfurth describes the country with admiration and extols its richness. "The Monbutto land greets us as an Eden upon earth."

The approach to this region, at present, is very difficult. The most enterprising explorers have not succeeded in traversing it or in penetrating it very far. The road to it, unless by the Dana, not yet proved feasible, is by ascending the Nile to Gondokoro, and so striking up to the extreme limits of the Nile basin, south and westward. It remains still to be successfully demonstrated that the vast reaches of the Upper Nile can be kept permanently clear of the floating islands of vegetation, which for months effectually dam the stream to the passage of boats. In the political complications in which Egypt is involved, it is questionable whether the Egyptian government can even keep up the show of sovereignty over the immense territories she has been annexing towards the equator. Extensive explorations would be requisite, and information not now accessible must be obtained before it would be practicable to begin missionary work here. It is one of the celestial visions of the Church Missionary Society, that some day it may stretch across this continental breadth of barbarism, so that its missionaries

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[28] Sir Bartle Frere, "Eastern Africa," ch. 2, gives some account of them. For more recent expeditions, "Proceedings of Royal Geographical Society," for August, 1879, p. 513.

[29] "This abstention [from religion], however, proceeds neither from indifference nor from skepticism. Far from being hostile to the preaching of the Gospel, the greater part of the members of the conference were of opinion that this preaching would be highly salutary, and might become the most active forerunner of the moral regeneration of the natives of Africa. History shows that Christianity possesses a special virtue for rescuing savage races from barbarism, and making them rapidly overstep the first barriers to civilization. This great and legitimate influence will not therefore be disregarded, but its guidance must necessarily rest in the hands of the Christian churches."—"Banning," pp. 114, 115, as below, note 2.

[30] For a full account of this movement, see "Africa and the Brussels Geographical Conference," by Emile Banning, member of the Conference. Translated by Richard Henry Major, F.S.A. With a Map. London, 1877, 12mo. pp xv, 188. *L'Afrique Explorée*, No. 1, for July, 1879, p 19, has an account, correct as far as it goes, of Mr. Stanley's new expedition. Also, "Proceedings of Royal Geographical Society," August, 1879, p 512. "Mittheilungen der Africanischen Gesellschaft in Deutschland," Heft I., 1878, full account of the German Expeditions, pp 10–16, 21–24; particulars of the International Africanische Association, pp. 24–45, Heft II., March, 1879, Heft III., June, 1879. For many other statements as to these societies, and as to other points in this paper not otherwise specified, the authority is private memoranda of personal conversations and interviews.

[31] As the value of information and suggestions depends upon the persons from whom the suggestions and information come, it may be proper to name some of those who have contributed favors of this kind. Among them are: Pasteur Georges Appia, Assesseur of the Société des Missions Evangéliques, Paris; Robert Arthington, Esq., Leeds, England; A. H. Baynes, Esq., Secretary Baptist Missionary Society, London; H. W. Bates, Esq., Secretary and Fellow of the Royal Geographical Society, London; Rev. Prof. Blakie, Edinburgh, now writing the life of Dr. Livingstone; M. E. Bertram Bocande, of the Portuguese Concession Company, Paris; Pasteur A. Boegner, Sous Directeur Société des Miss. Evangéliques, Paris; Prof. M. Burrows, of the University Mission, Oxford; Baron George von Bunsen, Berlin, of the Imperial Parliament, the Berlin Geographical Society, and the International African Exploration Society; Rev. Robert Bushell, Secretary of the United Methodist Free Church Missions Sheffield; Sir Thomas Fowell Buxton, Bart., Fellow and Ex-President of the Royal Geographical Society; Robert N. Cust, Esq., of London, formerly in the East Indian Civil Service, Fellow and Councillor of the Royal Geographical Society, of the Royal Asiatic Society, of the Christian Vernacular Society, Director of the Church Missionary Society, etc.; Rev. Prof. Theod. Christlieb, of Bonn; Rev. J. E. Carlyle, author of "South Africa and its Mission Fields;" Rev. E. Casalis, long a missionary among the Basutos, now Directeur of the Société des Missions Evangéliques, at Paris; John Coles, Esq., Fellow and Map Curator of the Royal Geographical Society, London; Commander V. L. Cameron, R.N., C.B., D.C.L., F.R.G.S., etc., etc., who preceded Stanley a year in crossing Africa; Herr Eick, of Barmen, many years connected with a trading company in Africa, and now preparing to labor there as a missionary of the Reinische Missions-Gesellschaft; Rev. J. P. Farler, formerly of the Universities' Mission on the Zanzibar Coast; Rev. Dr. Fabri, of Barmen, Director of the Reinische Missions-Gesellschaft; Col. James A. Grant, of the Indian Army, the African Explorer, F.R.G.S., London; Rev. H. Gratten Guinness, of the Missionary Training College, Bow, East London, and of the Livingstone Inland (Congo) Mission Committee; Edward Hutchinson, Esq., F.R.G.S., F.S.A., etc., Lay Secretary of the Church Missionary Society, London; Rev. R. W. Heanly, Secretary of the Universities' Mission; Rev. Dr. J. L. Krapf, the veteran missionary in Abyssinia and Eastern Africa, now at Kornthal, near Stuttgardt, at work on a new edition of his Suaheli Dictionary; Rev. John Kelner, formerly missionary in South Africa, and now Secretary of the Wesleyan Missionary Society, London; Rev. Dr. Kennedy, of the United Presbyterian Missionary Society, Edinburgh; Rev. Ed. Kratzenstein, of the Berliner Missions-Gesellschaft; M. le Baron de Lambermont, Ambassador Extraordinary and Minister Plenipotentiary, Secretary of Foreign Affairs, etc., Bruxelles; J. S. Maclagan, Esq., Sec'y for Miss. Com. of the Church of Scotland; John Muir, Esq., M.D., Edinburgh, of the Livingstone Mission Committee; Major C. H. Malan, of London, who is inaugurating native evangelistic labors in Africa; A. Marshall, Esq., Chairman of the African Com. of the London Missionary Society; Rev. Thos. Main, Convener of the Com. on African Missions of the Free Church of Scotland, Edinburgh; Rev. Dr. Robert Moffatt LL.D., F.R.G.S., etc., the veteran African Missionary and Explorer; A. McColl, Esq., of Leicester, who has traversed the Barotsé Valley, and is now taking charge of missionary explorations about the Congo in behalf of the Livingstone Inland Mission Society; Dr Gustav Nachtigal, who crossed the Sahara and pushed explorations through Soudan and the Lake Chad region, and now, just issuing his learned volumes of travels, is President of the Geog. Society and of the African Exploration Society of Berlin; the Right Hon. the Earl of Northbrook, G.C.S.I., late Viceroy of India, President of the Royal Geographical Society, etc., etc.; M. le Comte D'Outremont, Brussels; Major Alexander Alberto de Serpa Pinto, who has just returned from his perilous journey from Angola through Bihé and the Barotsé Valley to Natal; Rev. Robert Robinson, Secretary of the London Missionary Society; Rev. H. Rowley, of the Society for the Propagation of the Gospel, author of "Africa Unveiled," "The Early Years of the Universities' Mission," etc., etc.; E. C. Rye, Esq., Fellow and Librarian Royal Geographical Society; John Stephen, Esq., Glasgow, of the Livingstonia Mission Committee and of the Central African Trading Company; Rev. Dr. A. Schreiber, Barmen, Inspector of the Rheinische Missions-Gesellschaft; Hon. Henry S. Sandford, late U. S. Minister at the Court of Belgium, Brussels; Eugene Stock, Esq., Editor of the Church Missionary Society publications; George Smith, Esq., LL.D., C.I.E., etc., etc., Secretary of the Free Church Missions Board, Edinburgh; The Right Hon. the Earl of Shaftesbury; Rev. J. P. Thompson, D.D., LL.D., Fellow of the Geog. Society, and of the African Exploration Society at Berlin, etc., etc.; E. B. Underhill, Esq., LL.D., F.R.G.S., etc., late Secretary of the Baptist Missionary Society, London; Rev. Henry Wright, Canon of St. Pauls, Hon. Secretary of the Church Missionary Society, etc., etc; Henry Wright, Esq., a Director of the London Missionary Society; Rev. J. O. Whitehouse, Assistant Secretary London Missionary Society; Rev T. Wakefield, of the United Methodist Free Church Missions, many years at Ribe, and who has explored the region of Mt. Kenia; Rev. Horace Waller, F.R.G.S., etc., Rector of Twywell, Northampton, Editor of "Livingston's Last Journals, formerly of the Universities' Mission, with Bishop McKenzie, and a companion of Dr. Livingtone; Monier Williams, LL.D. etc., Prof. of Sanskrit, Oxford; W. H. Wyld, Esq., of the Staff of the Foreign Office, London; Sir Harry Verney, of the Council of the Royal Geographical Society, etc., etc.; Robert Young Esq., Assistant Secretary of the Free Church Missions Committee, Edinburgh.

In addition to these we take the liberty to name His Majesty Leopold II., King of the Belgians, who inspired and presided over the International Geographical Conference at Brussels, and who is making regal contributions towards the civilization of Africa.

[32] Stanley's "Through the Dark Continent," vol. ii., chs. 4–16. Cameron's "Across Africa," vol. i., ch. 17, to vol. ii., ch. 10. Livingstone's "Missionary Travels and Researches in South Africa," including a Sketch of Sixteen Years' Residence in the interior of Africa, and a journey from the Cape of Good Hope to Loanda on the West Coast; thence across the Continent, down the river Zambesi, to the Eastern Ocean. By David Livingstone, LL.D., D.C.L., etc., 1858, 8vo., chapters 17, 18. "The Last Journals of David Livingstone in Central Africa," from 1865 to his death, edited by Horace Waller, etc., vol. ii., chapters 3, 4, 5, 6. Stanford's "Compendium," "Africa," edited by Keith Johnston, chapters, 21, 26, 27.

[33] Krapf says seven or eight; others say four or five millions.

[34] Krapf, p. 72.

[35] Krapf and Rebmann; "Travels, Researches, and Missionary Labors during an Eighteen Years' Residence in Eastern Africa, together with Journeys to Jagga, Usambara, Ukambani, Shoa, Abessinia, and Khartum; and a Coasting Voyage from Mombaz to Cape Delgado." By the Rev. Dr. J. Lewis Krapf, Secretary of the Christian Institute at Basel, and late Missionary in the service of the Church Missionary Society in Eastern and Equatorial Africa, etc. With an Appendix respecting the Snow-capped Mountains of Eastern Africa; the Sources of the Nile; the Languages and Literature of Abessinia, Eastern Africa, etc., and a concise account of Geographical Researches in Eastern Africa, up to the discovery of the Uyenyesi by Dr. Livingstone in September last, by E. G. Ravenstein, F.R.G.S. [this last is of special value]. London, 1860, 8vo. Part I., chapters vi., viii., ix., xii.; Part II., chapters ii., iii., vi., vii., viii., and Appendix.—New, "Life, Wanderings, and Labors in Eastern Africa." Chapters vii.–xiv., xix.–xxiii. Sir Bartle Frere, "Eastern Africa," first letter. Stanford, "Compendium," "Africa," chapter xix.—The Geographical Society of Berlin announced at their sitting, January 4, 1879, the arrival of a detailed report from Herr C. Denhardt, engaged in exploring the Dana River. He had made a complete survey of the river for sixty miles from the mouth upward.

from Mombassa and Victoria Nyanza may join hands with its missionaries coming in from the Atlantic, along the Niger and the Binnuè.[36]

4. The three regions we have been canvassing are on the extreme northern part of Central Africa. The fourth region suggested for our occupancy is further south, between the great lakes Tanganyika and Nyassa, and thence westward.

Some of those who have specially called the attention of the Board to Central Africa think that this is where we ought to begin. It would be in close proximity to the fields of the London and of the Scotch Societies, whose coöperation would be generous and helpful. It is a region comparatively easy of access; from the ocean up the Zambesi, and the Shirè and Lake Nyassa. Gentlemen connected with the Glasgow Central African Trading Company assure us that the same facilities of transportation which they give to the Scotch Societies would be extended to our Board. The tribes in this region are of the same great family with the Zulus, so that our mission at Natal could furnish assistance in a mission here.

On the other hand, matters are in such a stage of development hereabouts just now that it would seem not wise to decide upon this field, if others as hopeful can be found elsewhere. The societies working on the two lakes are feeling their way inland, and may wish ultimately to cover this ground. While it may be true, as Sir Thomas Fowell Buxton said, that in this stage of Central African missions the various societies should not scatter too much, but keep near enough to support each other, even if afterwards some of them change to new regions; still it seems desirable in choosing our ground, to give the preference to the vast tracts which are wholly unevangelized.[37]

(To be Continued.)

THE EFFICIENCY OF SCREW PROPELLERS.

"EXPERIENCE," writes Bacon, "is the foundation of all knowledge." For "experience" substitute "experiment," and the aphorism will apply with great force to engineering science. In the absence of experiment we can but blunder about in search of the truth; and all attempts to use the imagination scientifically fail to do good service in helping us out of difficulties. Of nothing are these propositions more true than they are of the principles of screw propulsion. It is next to impossible to find two engineers or two shipbuilders who are agreed in their explanation of certain phenomena attending the action of screw propellers; and there can be no doubt that this diversity of opinion is solely the result of ignorance concerning the matter discussed. The ignorance is not willful—far from it. Nor do we use the word in an invidious sense. It exists and is widely diffused because experimental inquiries into the action of screw propellers and of the resistance of ships have never been pushed far enough. This state of ignorance is slowly disappearing, and the progressive speed trials being carried out by Mr. Denny and others will no doubt supply much valuable information.

We publish this week certain diagrams which are entitled to the most thoughtful consideration of all who are interested in questions concerning screw propulsion. This will be better understood when we say that they supply good ground for believing that the generally accepted theory that the power required to propel a ship at given velocities increases rather more quickly than the cubes of the speeds is erroneous, or that, at all events, it will not apply to extremely high velocities.

During December and January last Messrs. Yarrow and Co., of the Isle of Dogs, were engaged in conducting some very interesting experiments with propellers in order to determine the most suitable screw for a torpedo boat recently built by them for the Admiralty. These experiments embraced trials with twenty-five propellers, varying in diameter, pitch, and blade area. As each trial was conducted progressively in order to obtain curves of efficiency for each screw at different speeds, and as the speed eventually obtained by this boat was the highest ever recorded, namely, 21·9 knots, or over twenty-five statute miles, per hour loaded, these results cannot fail to be of great value, forming a valuable contribution to the general knowledge on this subject. It is through the courtesy of Messrs. Yarrow and Co. we are enabled to illustrate a few of the results obtained. It will be seen that each curve is accompanied by the leading particulars of the propeller and a general outline of its shape. Throughout the diagrams there is one curve, shown by a solid black line common to all, which is simply to serve as a ready means of comparison. This curve is that which would be formed if the power required to drive the boat varied as the cube of the speeds, assuming that 400 horse power gave a speed of twenty knots, which is fairly borne out in practice. Each result has been obtained as the mean of two or more experiments, and in no case has a result been considered final unless confirmed by subsequent trials, and each one so obtained is indicated on the diagrams by a dot. Referring to diagram No. 4, it will be seen that the line obtained is almost straight, apparently indicating that at speeds over eighteen knots the resistance does not increase in the very rapid ratio in which it is commonly held to augment: This is confirmed by diagram No. 6, and also by other experiments made by Messrs. Yarrow and Co. This is a very promising feature for the possible increase of speed in the future.

One very remarkable fact which was ascertained during the experiments was the influence which the elasticity of the propeller blade had on its efficiency; and this was confirmed without exception and in a most marked degree, the thin and elastic blade in every case giving a superior result to a rigid blade. In diagram No. 1 will be seen two curves, A and B. These were obtained from two screws of precisely the same dimensions, pitch, diameter, blade area, etc., excepting only the thickness of the blade. It was found when running at a speed of 16 knots that the tip of the thin blade bent forward during one part of the revolution to the extent of 1¼ in., and at a speed of 17 knots it bent forward 1¾ in., and at a speed of 18 knots it bent 3 in., coming back when at rest to its original shape; beyond this speed the blades became permanently bent. It is reasonable to suppose that in an efficient screw the work done by any one blade should be equal to that done by each of the others, also that it should be uniform throughout the revolution, and it is not improbable that the elasticity of the blades tends to conform to these conditions, and further, if it is proposed in designing a screw to turn to good account this elasticity, the blade should be proportioned so that in bending forward its pitch should be reduced, which will be a further means of equalizing the work done by each blade. Messrs. Yarrow even go so far as to question whether during certain portions of the revolution there is not actually a pressure on the back of the blade in the opposite direction to the motion of the boat, when propellers are used having little slip, of large diameter, and high speed.

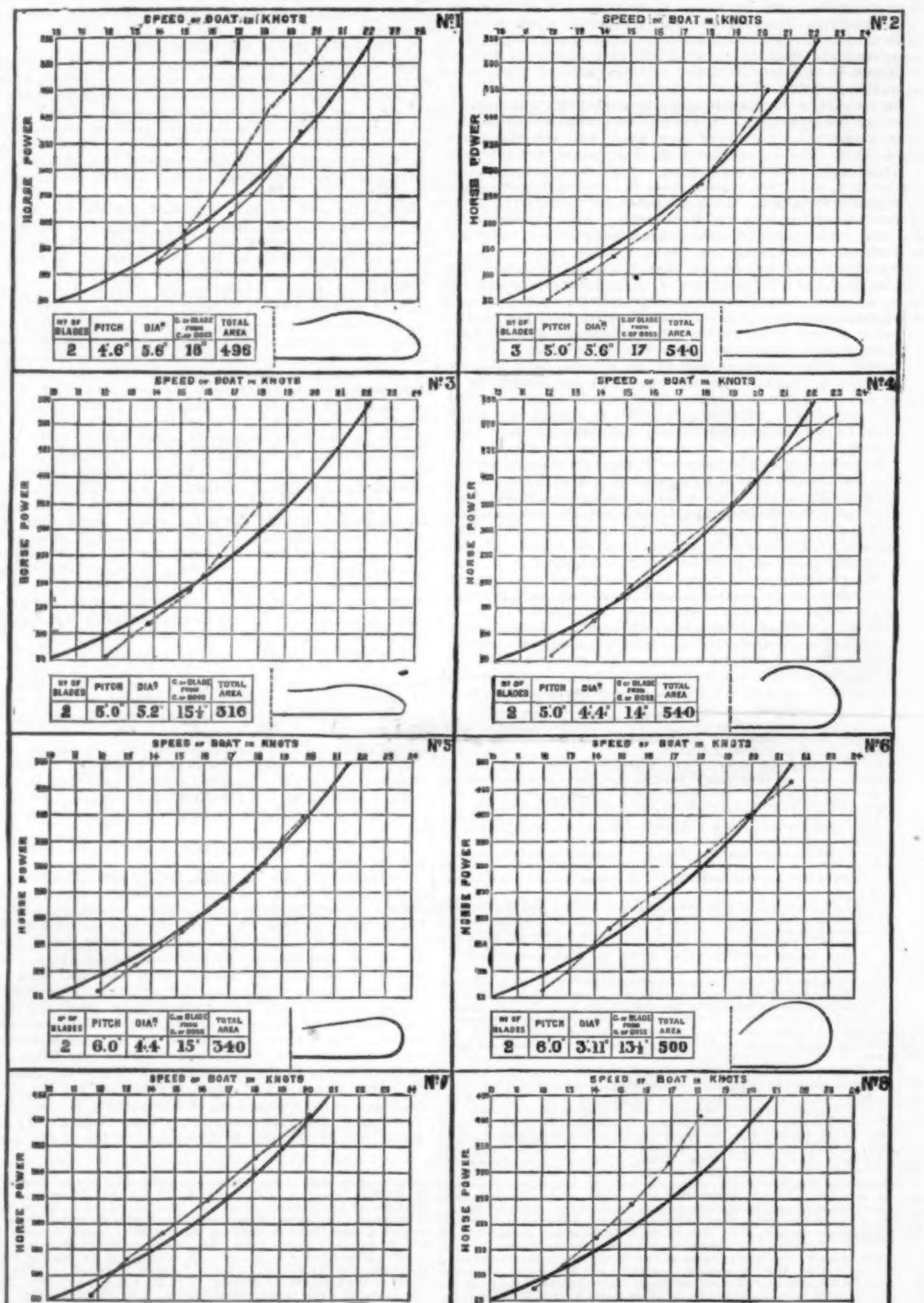
One noticeable feature was more or less confirmed throughout the experiments, namely, that screws of most efficiency were those which had least variation of slip at different speeds, while on the other hand, those having at a slow speed a negative, or a very small slip, were without exception bad. It is interesting to compare, as an example of extreme cases, diagram No. 1 (curve A) with diagram No. 8. The screw employed in the former, it will be seen, is large in diameter and of fine pitch; while in the latter it is small in diameter and of coarse pitch; these two propellers, although so widely different, actually were productive of almost identical results, and when taken in comparison with the other diagrams, are clearly extreme cases, both representing propellers of inferior efficiency, suggesting that the best screw would be one proportioned somewhere between the two, which, as the diagrams show, was eventually found to be the case. One fact which these experiments tend to prove is that propellers giving the best results at high speeds are not the best for slow speeds. This is more particularly marked by diagrams 2 and 6. These experiments prove most conclusively the importance of sparing no pains in proportioning the propeller to suit the conditions under which it work, and the immense loss that may be occasioned through not doing so. Throughout the trials the boat was loaded to a displacement of 27 tons, being 3 tons less than when in fighting trim.

We may proceed to examine the diagrams more in detail. No. 1 shows that a velocity of about 20·4 knots was obtained with 550 horse power. Seven runs were made, at speeds varying gradually from 14 knots. Each dot represents the mean of two or more runs. In this case the screw A gave bad results throughout, up to 18·25 knots. From this point its efficiency nearly coincided with the cube of the power; but at the highest velocity obtained it will be seen that a wide interval separates the line, A, from the dark standard line; 550 horse power ought to have given a speed of over 22 knots; as a fact it gave 20·4 knots. The results obtained with screw B are in every way superior. Sets of runs were made with it, from 15 knots up to about 19·25; and it will be seen that the curve approximates very closely at the higher speeds to the standard curve.

In diagram 2 we have the results of seven runs at progressively increasing speeds. The work of the propeller is unsatisfactory. The speed curve is very regular, and continually gets worse. It is evident that the higher the velocity the smaller would the efficiency of this propeller have been.

In diagram 3 we have a still stronger example of the same fact. Six runs were made with this screw, but it was useless to push them beyond a speed of 18 knots, as it was evident that the speed curve had clearly a bad tendency, and that the higher the velocity the wider would be the interval between it and the standard curve.

In diagram No. 4 we have a very different result. The speed curve is almost straight till a speed of 20 knots is reached, beyond which it diverges strongly in the right direction, and a speed of 23 knots was obtained with about 520 horse power, the resistance of the boat thus apparently augmenting in a far less rapid ratio than the cube of the speed. This was the most satisfactory propeller of all those tested, and our readers may with advantage compare the proportions of this propeller with those of diagrams 1, 5, and 6. The screw No. 6 gave a vary fair result, and the



CURVES SHOWING EFFICIENCY OF DIFFERENT SCREW PROPELLERS.

[36] Schweinfurth's "Heart of Africa," both volumes. Long's "Central Africa; Naked Truths of Naked People. An Account of Expeditions to the lake Victoria Nyanza and the Makraka Niam-Niams, west of the Bahr-el-Abiad (White Nile)." By Col. C. Chaillé Long, of the Egyptian Staff. 8vo, 1876. "Journal of Society of Arts, June 2, 1876, pp. 693 seq. Paper by Edward Hutchinson, Esq. Stanford's "Compendium," "Africa," chapter 16. The field which the American Missionary Association has been asked to enter lies east of the Niam-Niams.

[37] Livingstone's "Last Journals," vol. i., chapters 7, 8, 9; vol. ii., chapters 10-13. "The Lands of Cazembe." Lacerda's "Journey to Cazembe in 1798," translated and annotated by Capt. R. F. Burton, F.R.G.S. Also, "Journey of the Pombeiros P. J. Baptista and Amaro José, across Africa, from Angola to Tette on the Zambesi," translated by B. A. Beadle; and "A Résumé of the Journey of MM Monteiro and Gamitto," by Dr. C. T. Beke [published by the Royal Geographical Society], 1873, 8vo. Stanford's "Compendium," "Africa," chapter 21.

speed curve, like that of No. 4, is full of promise that as the velocity increased so would the efficiency of the propeller. The remaining diagrams our readers will be able to interpret for themselves.

The thanks of the community are, we think, due to Messrs. Yarrow & Co. for placing at the disposal of the world, through our pages, information which has been obtained at considerable expense and with much trouble and hard work. The facts can hardly fail to modify received opinions concerning the action of screw propellers at high velocities at all events; and the whole series will no doubt be cited as a standard contribution to the literature of the subject for very many years to come.—*The Engineer.*

HEATHORN'S STEERING GEAR.

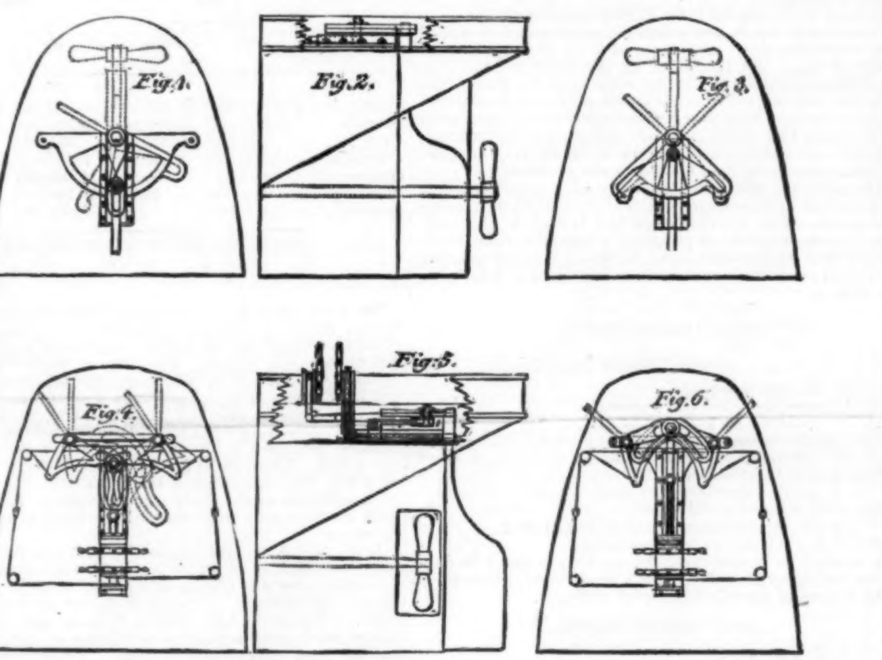
WE annex illustrations of a steering gear devised by Captain Heathorn, which enables the rudder, or rather rudders, for two are employed, to serve to check the way of as well as steer a vessel. The drawings show the details of the different methods adopted under varying circumstances, but in all the principle is the same. Each rudder is moved by a horizontal slotted lever, in the slot of which travels a stud mounted on the end of another lever, which lever again is an auxiliary tiller.

The pivot upon which this tiller or lever works is mounted on a nut carried by a screw thrust by a piston, or pulled by a chain over a pulley, and guided by a guide bed or guide bars.

Upon this screw being turned, chain hauled, or piston thrust, the nut is carried along, and the stud thereon acting in the slots of the levers so affects both rudders that they are thrown outward; in fact, the action of the ordinary steering gear working by the tillers is to cause both the rudders to move in the same direction and steer the ship, while the action of the screw or piston on the tillers is to cause the rudders to move in opposite directions and stop or tend to stop the ship's way. Moreover, these rudders not only steer the ship themselves, but deflect the column of water passing between them, causing it to increase the effect.

The mechanical movements above mentioned are also applicable to other purposes, amongst which that of loading heavy guns; but we are not in possession of the drawings for that work.

Figs. 1, 2, and 3, show a single screw propeller abaft the rudders, which lie close to the keel of the ship on either side, the screw shaft works between them, and the drawings illustrate "straight," "steering," or "both open for check ing way." Figs. 4, 5, and 6, show rudders on either side of the screw in a position to deflect the rejected water, and thereby assist steering.—*Engineering.*



HEATHORN'S STEERING GEAR.

FIRE-BRICK AND TERRA COTTA.

By ANDREW MCLEAN PARKER.

I.—THE FIRE BRICK PROCESS.

FIRE-BRICKS are made from clay, of which the greater part is kaolin, and which contains a variable amount of uncombined silica either as coarse or fine sand. These fire-clays abound in the region about Woodbridge and Perth Amboy, N. J., in the coal regions of Pennsylvania, in the Ohio coal fields, and elsewhere in the country. The Woodbridge clays occur in a belt or formation classed in the New Jersey Geological Survey as the Woodbridge fire-clay bed. This varies very much in thickness; in some banks not occurring at all, and in the adjacent ones found from eight to twenty feet thick, covered by top dirt and poorer clays. When dug, the clays are very wet, and in some cases they are exposed to the weather for a considerable length of time, more generally so in England than here. In our country the practice is to let the clay drain as dry as possible, and then store it in airy sheds. When it is as dry as it will become in the air, it is ready to be worked up. It goes through a pair of rolls 15 inches in diameter, carrying teeth 3 inches long, set in rows. The teeth are 3 inches apart and the rows 4 inches. The teeth in one roll mesh into those on the other, breaking the clay into small pieces. It goes then to the mixing pits, where the proportions of the other ingredients are added, the whole mixture being turned over roughly with spades. The proportions added are the secret of each maker, are determined by practice, and vary according to the nature of the clays used.

What is called a stiff clay requires less cement to bind it than a fat one. Generally about 30 per cent. of this is taken. The cement or "grogg" is first quality fire-clay, burned very hard and powdered; it is angular, white, and extremely infusible.

The other ingredients are fire-sand, a very pure, sharp sand, and less pure fire-clays. In some cases makers substitute, in part for the cement, a material called "spar" or feldspar. This is a coarse quartz gravel, carrying from 15 to 20 per cent. of Al_2O_3, and makes a good cement. These extra materials are infusible and unaltered in the highest heat of the kiln, and serve to hold the brick in shape in the fire, and also to prevent shrinkage, as fire-clay alone will warp and shrink very much. The rough mixture taken from the mixing pits is thrown into a pug mill, and the moist mixture is squeezed into shape by a pressing machine at the bottom.

The bricks are roughly moulded in cherry-wood moulds, which are sanded each time before pressing the clay into them, so that the brick are easily shaken out of them on the drying floor, where they are allowed to stay till they may be handled without changing shape, usually from two to two and a half days. They next go to the drying yard, where they stay from six to ten days, according to the weather, being packed up and kept under shelter in case of wet weather. Finally, they are carried to the drying sheds, where they remain from two weeks to two and a half months, depending on whether or not they are needed. If they are in a hurry for them, they are dried on racks over coils of steam pipes. Up to the time of their going to the sheds they have a shape approximating their final shape; accordingly, they are pressed to a uniform size previous to being piled in the sheds. The next step is the burning, which is done in two types of kilns, rectangular and round. The round kilns are about 25 feet in diameter and 16 feet high, the top being a flat arch perforated with holes to let the smoke and gases escape, and which tend to make the draught uniform, the whole being surmounted by a chimney of variable height, to create a draught. The fire-places are six in number, arranged in radial lines under the body of the kilns, running nearly to the center. A main flue is there built of old brick, and a flue over each fire-place at about three-quarters the distance from the center to the outside. These make the draught uniform and carry the fire evenly to all parts of the kiln. In the rectangular kiln the fires are built on grates running under the structure from side to side. The walls of this kiln are permanent, are 2 feet 6 inches thick, and the kilns are from 25 to 30 feet long, and 14 to 18 feet wide outside. The fire-places are arched over with fire-brick, leaving a space 8 inches wide for the heat to pass up. A trouble with these kilns was that a current of air would enter the fire-places at the ends of the grates, pass over the coal, and go up the walls of the kiln, cooling all the brick on the outside of the pile, and preventing their burning hard. This is obviated by having a grate at the end of each fire-place, which, after charging, is raised at an angle of 45°; this, when covered with slack coal, effectually prevents the entrance of air except below the grate. The fires are kept up five to six days, and with a temperature at the end of the operation sufficient to melt silver; in this time the brick are burned hard, as shown by trial, pieces of the fire-brick mixture being taken out of different parts of the kiln through openings made for the purpose. When the bricks are burned the fires are lowered, and in from ten to eleven days from first firing the bricks are cool and the kilns can be drawn. The chemistry of the fire-brick is explained by authors as follows:

The basis of all clays is supposed to be the so called mineral kaolinite. This is a hydrated silicate of alumina which is by itself infusible; the formula is $Al_2O_3, 2SiO_2 + 2H_2O$, or 46·3 per cent. SiO_2, 39·8 per cent. Al_2O_3, and 13·9 per cent. of H_2O. When fired, the water of composition is driven off, and we have as a result a simple and hydrous silicate of alumina which is hard, no longer plastic, and fusible with great difficulty. No fire clay is absolutely pure, nor does it consist of this hydrated silicate alone. Other silicates of alumina, the sulphide, titanate, and oxide of iron, and combinations of lime, magnesia, potash, and soda occur. The action of the iron compounds is a fluxing one; the oxide present is the protoxide, and this uniting with the silica under favorable conditions makes an easily fusible compound, something similar to the scouring cinder of the blast furnaces. The sulphide acts in somewhat the same way, making a black slag, easily fusible. The action of the titanate is not well understood, and is of but little consequence because of the small percentage present. The lime and magnesia, when present, seem to produce a good effect. Potash is very objectionable in clays, because of the readiness with which its compounds are fused; its presence is generally discovered by the taste.

From the analysis nothing can be determined of the fire properties of the clay. This seems to indicate that something more than the chemical composition governs the refractory properties, but this something is not yet understood. Some clays run high in potash and iron, the two worst constituents, and yet are the very best brick clays; while others, which differ from these but a very little in alumina and silica, are worthless. The bricks are moulded to suit any parts of the furnaces used in the different manufacturing processes for the metals, and thus save time and expense in laying them.

The celebrated Dinas brick was made from a sand containing 98·31 per cent. silica. This was powdered, "mixed with one per cent. of lime and sufficient water to make it cohere slightly by pressure. They were fired seven days and cooled the same number," the lime serving as a cement to bind the sand grains.

II.—THE TERRA COTTA PROCESS.

The terra cotta clays are of an entirely different nature from those already mentioned. They contain iron up to seven per cent., and are not refractory to any great extent. Two shades of terra cotta are made on a large scale, buff and red, and almost any shade can be produced, if desired. The clays are subjected to a preliminary treatment before being fashioned. Each kind is thrown into a washer, a box 10 feet long, 4½ feet wide, and 6 feet deep, half filled with water. In this it is stirred up by a revolving shaft, fitted with hooked arms set in a spiral line, and is suspended and carried off in the water. This slip, as it is called, is strained through a fine sieve, which separates the iron, grit, sand, etc., in the crude clay. The clean slip runs into evaporating vats, 12 feet long, 8 feet wide, and 8 inches deep. Two weeks to twenty days are required to evaporate the water, when the material goes finally to the storage vaults. When it is desired to make any article, the clays are measured and mixed in a pug mill, the proper cement is added and run through again, and the clay is then ready to be worked up. In the Perth Amboy Terra Cotta Works four clays are used. The base of the red terra cotta is a clay from the neighborhood running quite high in iron; of the buff, a second clay, lighter, and nearly free from iron. A yellow clay from Baltimore is the second ingredient, and two other clays from the locality are taken to fill up.

The proportions are: of the first, 3 parts; of the second, 1½ parts; of the third, 1 part; and of the fourth, ½ part. To this clay mixture thirty per cent. "grogg" is added. This is powdered terra cotta burned very hard, and stands more heat than the ordinary article, serving to hold it up in the fire. In burning the ware, great care must be taken not to let the fires become too hot, nor to burn too long, as a few hours will change red to brown, and finally to black, when it is ruined for its purpose. Objects are carved out of the blocks of clay direct, or are moulded in plaster moulds. If two objects of the same pattern are to be made, it is cheaper to carve both than to take a cast of the first to build the second form. But if several are wanted, one is carved or modeled in clay, a cast taken of this, and this cast serves as a mould for the succeeding ones. Allowance is made for shrinkage by building the green work one-twelfth larger than the finished piece is required. The best lengths for firing are: for buff, from 1 minute 10 seconds to 2 minutes 4 seconds, and for red, 1 minute 9 seconds to 2 minutes. Objects are burned "on the end," in preference to "the flat," as the shrinkage is much more regular in that position, and warpage is less liable to take place. Excellent imitations of different building stones can be produced in this material, and serve especially to take the place of carved stone. A granite panel, for example, is made in buff, into the body of which is introduced a small quantity of pure oxide of iron or fine filings. The oxide is reduced to metal in the kiln, and melts through the body of the ware, making dark spots all over it and imitating the lighter granite very closely, at one-tenth the cost of carved stone. This material is one of the readiest the builder has at hand. It is strong—bearing four hundred pounds to the inch—fire-proof, handsome, and comparatively inexpensive. It can be made to take the place of cast iron, with half the weight and a third of the cost. Only small pieces can be made, however, as it is found to warp, shrink, and crack in spite of all precautions if the dimensions be excessive.

Some very interesting work has been carried out of late by the Perth Amboy Terra Cotta Company for the Long Island Historical Society building, in Brooklyn. The structure is a large one, and the two fronts are almost entirely terra cotta. A notable feature is the main entrance. A doorway twelve feet wide is surmounted by an arch; in a panel in this, at the top and to the left, is a colossal head of a Norse warrior surrounded by the paddle, hook, chain, rope, etc. On the right, in contrast to this, is an Indian's head, surrounded by his implements, the bow, pipe, spear, tomahawk, etc.

A church in Baltimore presents another specimen of what may be done with this valuable material. An arch was required over the chancel, to be 44 feet span, with a soffit 15 inches deep, and yet not over 7 tons in weight. This was impossible in iron, perishable and weak in wood, but practicable with terra cotta brick. A buff shade was employed, and the front of each brick was paneled and decorated; they were built hollow, and an air space was carried around inside the arch.—*School of Mines Quarterly.*

BRICKLAYING IN FRANCE.

[Extracts from artisans' reports on the French Exhibition of 1878.]

BOTH in Paris and in the towns and villages outside, bricklaying seems to be the work of only two schools of bricklayers of definitely fixed methods. The sameness of execution and sameness of design in these two typical methods is very remarkable. The execution consists, without exception, in laying the bricks in mortar, in a manner known "as left for pointing," and in afterward stopping in the joints, and laying on, with a three-eighth inch jointer, a white joint in either plaster or putty. This is the method adopted for the best description of work. The only other mode of finishing the facework consists in laying the bricks as in the first instance, and then stopping in with white stopping. The whole is afterward colored to the required shades, and the joint brought out white by plowing into the stopping with a jointer run along with a "straight edge" rule, to the depth of about one-fourth of an inch. The width of the joints is about three-eighths of an inch, alike for the bed and cross joints.

In laying bricks for pointing or external plastering, the French workmen make no attempt to "fill the joints," but

leave them gaping and open to a depth of about three-fourths of an inch, so that no "raking out" is required. Such performance would not be sanctioned by an English clerk of works, or suit the taste of English bricklayers, although, it must be confessed, a better key for either stopping or plastering is thus obtained than by the "raking out" process. Whether the French have borrowed or adopted "tuck pointing" from the English I cannot say. They call it "English jointing," or *joint anglais*. In my opinion a good lesson might be learned from them if their mode of mixing and the materials which they employ could be accurately ascertained. The joints have a glazed appearance, and are very hard; and I have not noticed a single instance in Paris of the crumbling away or falling off of the joints, so frequently seen in England.

This may, in some measure, be due to the difference in the action of the two atmospheres, or to the less frequent sudden changes from soaking rains to freezing which occur in Paris. Whether this be the case or not, I am convinced that the more capillary absorption is avoided, by the employment of materials of a more dense and less porous nature in the construction of joints, the less will be the subsequent disruption of our work by the expansion of the water lodged in the pores upon the occurrence of freezing. From what I can make out by the examination of both old and new work, the durability of the French pointing is due, in a great measure, to the employment of a more dense and consequently less absorbent material than we use, and to the giving a better key to the stopping, by the method of leaving the joints open, as has been described.

The only artistic effect produced in brick work, in Paris, is the almost universally adopted checkered, lozenge-shaped, and square patterns, which are supposed to be done in various-colored bricks, namely, light, dark, red, and blue; but which is not unfrequently the work of the pointer, or of the painter, rather than the laying in regular bond of a design in brickwork by the bricklayer. Such artistic work and careful execution as is instanced in the red brick mansions of the "Queen Anne" style, and other buildings in brickwork in England, where the geometrical knowledge, the artistic taste, and the neat workmanship of the English bricklayer are exemplified with such pleasing effect, is not easily to be found in Paris.

The extent to which ornamentation in bricks and artistic brickwork is adopted by French architects may be fairly judged, since it may be assumed that France, as a whole, is represented at the Exhibition. If any steps had been recently taken to improve the French style of brick buildings, this would certainly have been shown there in some way. I have also examined drawings in the architectural and civil engineering departments, and although these indicate a tendency to more general use of bricks in the provinces, in prison, school, and dwelling-house architecture, yet nothing appears in this material in the way of mouldings, cornices, caps, gauged arches, niches, scrolls, or carving, as is seen in almost every town in England, to a greater or less extent. In fact, ornamentation in domestic architecture does not seem to run very high in France, so far as I could judge from what I saw of Paris and the few places outside its walls which I visited. The French appear to delight in decorating their public places and edifices to any extent, but do not apply the same rule to their houses, and are therefore very unlike the English, who take pride in the appearance of their homes. This is the cause of the variety of styles, and of the competition in street architecture in England.

The rate of wages paid to the bricklayer in Paris is 70 centimes per hour (7d. English) for journey-work. The hours of work are from 6 A.M. until 6 P.M. under one method, and from 6 A.M. until 5.30 P.M. under the other, there being a movement started in Paris which aims at the reduction of the hours of labor. Work is carried on on Sundays the same as on other days. The hours made during the week are 77 under the first and 73½ under the other system. The earnings of the bricklayer in Paris thus amount to 53 francs 90 centimes for a full week of 77 hours, or £2 3s. 1½d. of English money. For 73½ hours the sum is 51 francs 45 centimes, an amount equal in English money to £2 1s.

I understand that a bricklayer will execute about two meters cube of brickwork in a day. That would be equal to laying 900 bricks in 11 hours. This number is less by about 300 to 400 in the 11 hours on similar work as compared with the day's work of the Englishman. I very much question, however, the exactness of this statement from the little I saw of the French mode of bricklaying while at Paris, and from the experience I have had of working with them in Portugal, for about three years.

The cost of bricks per 1,000 in Paris varies from 55 to 64 francs according to quality. The sizes of the ordinary building bricks are somewhat smaller than ours, being 8¾ inches by 4¼ inches by 2¼ inches approximately, and compared with ours for prices are somewhat cheaper, stocks in London now being about 50s. per 1,000 for seconds, while bricks of the second quality in Paris are 60 francs, or 48s. per 1,000. Fire-bricks (black) are 70 francs, Bourgogne 85 francs, *refractaires* 100 francs per 1,000.

Tiles range from 50 francs to 105 francs per 1,000, or 40s. to 84s. The first is the price of the ordinary *carreaux à pans rouges* of first quality, or red tiles, the second that of the white Bourgogne tiles.

Portland cement, or *ciment Passy*, which is similar to it, in Paris is 6 francs per 100 kilos, equal to about 2s. 4¾d. per bushel, weighing 110 pounds, or 4s. 9½d. a sack of 2 bushels. Roman cement is 5½ francs the 100 kilos, or about 4s. 4½d. the sack of 2 bushels.

One cubic meter of lime costs 21 francs, which would be equivalent to 11s. 9d. per cubic yard.

Plaster of Paris is 18 francs the meter cube, or 27½ bushels. Therefore a 2 bushel sack would be about 1s. 2¼d. This price, as compared with ours, seems incredible, being only one-fifth of the price charged in England. The cheapness of plaster may account for the almost indiscriminate use of it in building operations. I noticed that the French plasterers do their pricking up with plaster, and use only about one-fifth the quantity of laths we do, theirs being nailed about 4½ or 5 inches apart. The ceilings are pricked up, or rather pugged in, on a boarded sheeting, fixed up under the laths, which is afterwards struck, and the finishing done from beneath with plaster also. Brick and stone work is also done in plaster and sand, and external plastering to a very large extent. The plaster comes from Montmartre, Marly, and elsewhere. The depot is on the Quai Jemmapes.

The tools of the French bricklayer differ only in the trowel and mortar-trough. The latter is the same as used in some parts of Scotland, and with mason's fixers, and is similar in shape to a washing-tray. The French trowel would, undoubtedly, be an awkward tool for an English bricklayer to use, as it cannot be employed for cutting or trimming bricks, a process which is accomplished by another tool, the brick-hammer. The spreading the mortar and cutting are both done in England by the trowel, which may be said to serve the purpose of hammer and trowel as well. The French tool seems to be made to suit the trough, rather than for laying bricks and "striking joints." There is a peculiarity about the French laborer's hod, which I saw in use on the ground only; whether it can be carried up a ladder I cannot say. It consists of boards put together to form sides about 1 foot 10 inches by 1 foot 2 inches. These are set at right angles, like the bottom and one side of a box. The side which forms the bottom is then fixed upon two short poles, one to rest on each shoulder, and be held by one hand. The side which stands up prevents the mortar, which is loaded on by an assistant, from slipping down about the bearer's neck and back. There are two brackets fixed to the under side of the poles, which, bearing against the back, serve as stops to prevent this clumsy implement from slipping forward. I say clumsy, because it cannot be used by less than two men, one to fill and the other to carry. It may be possible that more stuff could be carried by it than by the English hod. But the way in which I saw it loaded did not seem to indicate that it was customary to overload the bearer.—*Architect.*

IMPROVED TANNING PROCESS.

Dr. Chr. Heinzerling, of Frankfort-on-the-Main, has invented a new tanning process, which produces better and more durable leather, and is from 20 to 25 per cent. less expensive than the old methods. The greatest advantage that it possesses over the old methods is that it requires but three to five days instead of as many months.

The raw hides are unhaired and swelled in the ordinary manner, and are then placed into a solution of acid bichromate of potash, or acid chromate of soda, or acid chromate of magnesia and alum, or sulphate of alumina and salt. They remain in this solution for a few days, according to the thickness and quality of the hides and the concentration of the solution.

Instead of placing the hides directly into one of the above solutions, they can be first submitted to the action of a solution containing about 10 per cent. of alum and some small pieces of zinc. By the action of the alum and the zinc, amorphous alumina (clay) is deposited upon the fibers of the hide and prevents an injurious action of the strong solutions. If the hides have been in the above solutions of soda or alum for a certain time, a few per cent. of yellow or red prussiate of potash are added, which will prove to be very effective for the leather to be used for the uppers of shoes.

They are then placed into a solution of chloride of barium or acetate of lead, or soap, for a few days, to fix the tanning substances. They are then dried and treated in the ordinary manner with fat, or paraffine, or naphtha, dissolved in benzine and similar substances, to which a small quantity of thymol or carbolic acid should be added.—*Deutsche Industrie Zeitung.*

PRINTING RECEIPTS.

AMBER "STEAM."

15 lb. gum substitute.
*1½ noggin "olive oil"—*neutral.*
3 gallons bark liquor at 12° T.
4½ gills sapan liquor at 8° T.
3 quarts red liquor at 16° T.
Half boil and add—
6 oz. tin crystals.
Mix until dissolved, and add—
¼ of a noggin oxymuriate of tin at 120° T.
Mix well and strain as fine as possible.

It is requisite in dissolving the tin crystals that it be done in the red liquor, in order to get a good color, at the rate of three ounces of crystals to the pint of liquor.

DARK "STEAM" BROWN.

6 lb. gum starch.
9 lb. satin gum.
2 pints of olive oil.
6½ quarts red liquor at 17° T.
6 pints acetic acid at 7° T.
4 gallons catechu liquor.
4 lb. chloride of ammonia.
4 quarts of sapan liquor at 8° T.
4 quarts of logwood liquor at 10° T.
1 quart of acetate of copper.
1 quart of nitrate of copper at 86° T.
Boil well and strain.

"STEAM" GREEN.

2½ lb. starch.
1½ gallon bark liquor at 16° T.
Boil and add—
9 oz. alum.
1½ oz. oxalic acid.
3 oz. tin crystals.
When half cold add—
1 lb. 14 oz. tartaric acid
3 lb. 6 oz. yellow prussiate of potash.
3 gills tin pulp.
1½ noggin Galipoli oil.
After steaming, pass through—
Chrome liquor at 4½° T.
Wash in clean water, and dry up.

"STEAM" PURPLE.

1½ gallon logwood liquor at 16° T.
1½ gallon red liquor at 20° T.
1 oz. carbonate of soda.
5 oz. crystal soda.
¾ lb. of red prussiate of potash.
¾ lb. of oxalic acid.
10 lb. gum Senegal.
Boil, cool, and strain. —*Chemical Review.*

Glycerine and Carbolic Acid for the Preservation of Hides.—Green hides are said to be preserved perfectly soft and fresh, by brushing them on the flesh side, by means of a white-wash brush, with a mixture of 90 parts of crude brown glycerine and 10 parts of 50 per cent. carbolic acid. They recover all the properties of freshly slaughtered hides by simply freeing them from the preservative by washing. Experience alone can tell whether the advantages over salting hides will compensate for the increased expense.

* 1 noggin=¼ pint.

Preservation of Food in a Vacuum formed in a Steam Digester.—Markl suggests that articles of food, as those left from a meal, may be kept indefinitely without change in the vacuum produced in a Papin's digester, by simply heating them to a boil in it, with the cover on, and allowing the stop-cock to remain open for a few seconds for the escape of the air, with some steam, and removing the vessel, after closing the stop-cock, from the fire, when the steam will condense. By opening the stop-cock at any time, for the admission of air, the lid can be readily taken off, and the articles removed.

[Continued from Supplement No. 207, page 3293.]

[From the Princeton Review.]

COMPARATIVE VIEW OF AMERICAN PROGRESS.

There remains now but one important interest to consider in our comparative view of American progress. Of all pursuits, mining is the most varied and least certain. In 1853 California produced $65,000,000 of gold, and as late as twenty years ago its annual product amounted to $50,000,000. At that time Russia produced about $16,000,000 a year, and Australia about the same as California. At the present time the product of California hardly exceeds $16,000,000 a year, while that of Russia amounts to nearly $25,000,000. But the Union Pacific Railroad has opened up other mines besides those of California, and the production of precious metals in 1878 was greater than in the year preceding. The chief attractions now are the silver mines located along the vast region traversed by the Pacific Railroad. The first discoveries of silver within it were made in 1859. At that time the total product of the United States equaled only $200,000 annually. The product the past year equaled $46,726,314, of which $41,311,677 was from the States and Territories tributary to the Pacific Railroad.* The following table will show the product of gold and silver in the States in question for 1877 and 1878:†

States.	1877		1878.	
	Gold.	Silver.	Gold.	Silver.
California..	$15,000,000	$1,000,000	$15,260,679	$2,373,387
Nevada ...	18,000,000	26,000,000	19,546,513	28,130,350
Utah......	350,000	5,075,000	392,000	5,288,000
Colorado...	3,000,000	4,500,000	3,366,404	5,394,940
Oregon ...	1,000,000	100,000	1,000,000	100,000
Washington	300,000	50,000	300,000	25,000
Dakota.....	2,000,000	....	3,000,000	....
Total	$39,650,000	$36,725,000	$42,865,596	$41,311,677

The total amount of gold and silver produced in the United States in 1877, according to the same authority, equaled $84,050,000, of which $45,100,000 was gold and $38,950,000 was silver. The amount produced in 1878 equaled $93,952,421, of which $47,226,107 was gold and $46,726,314 was silver. The product of the United States for 1878 equaled one half that of the world; that of the territory opened by the Pacific Railroad for the past year equaled $84,176,273, or nearly one half of the product of the world. There are few men amongst the most intelligent who fully comprehend the wonderful importance of such railroads as the Pacific and Northern Pacific roads until the facts are almost dramatically brought to their observation.

It has been long since enunciated that man follows, or at all events tries to follow, the lines of least resistance, when his movements are free as within the wide-spreading area of the United States. It has been shown elsewhere that in this way industries have shifted to those spots where they are pursued under conditions admitting the greatest return for the least expenditure of labor. It now remains for us to find out by the aid of such facts as we have at hand the present drift of our population. It has been truly said that it is only by a close observation of the entire field before us that we can realize something of the distribution of man, and even attain to some apprehension of the set of the tides of humanity reserved for the future.

The manufacturing States of the West are (if the figures of the Bureau of Statistics are worthy of credence) better places for the mechanic than the Eastern or the Middle States. I have compiled the following tabulated statement showing the average annual weekly earnings and the annual expenditures of the families of workingmen in the Eastern, Middle, Southern, and Western States respectively:‡

Eastern States.	
Total average yearly expenditures	$670 22
Total average weekly earnings..	15 14
Total average yearly earnings	787 28
Middle States.	
Total average yearly expenditures........	$786 52
Total average weekly earnings............	18 95
Total average yearly earnings	985 40
Southern States.	
Total average yearly expenditures.........	$818 07
Total average weekly earnings............	16 09
Total average yearly earnings	836 76
Western States.	
Total average yearly expenditures..... ..	$714 75
Total average weekly earnings............	18 19
Total average yearly earnings	945 88

From the above figures we may make the following summary:

	Annual Saving.
1. Western States...........................	$231 13
2. Middle States...........................	198 88
3. Eastern States...........................	117 06
4. Southern States...........................	18 69

These figures naturally suggest the inquiries: Is the West as promising a land to the manufacturer as it is to the agriculturist? Will it attract both industries? Let us

* "The Pacific Railroad," by Henry V. Poor (*North American Review*, June, 1879).

† Report of the Superintendent of the U. S. Mint.

‡ Compiled from statements published in Mr. Young's work on "Labor in America and Europe," 1874, Washington, D. C.

compare the three sections. In this comparison Ohio will be left out as the connecting link between the East and West. Maryland, Delaware, and the Pacific States will also be omitted, that we may better deal with the distinct sections of the country, and base our inquiry as near as possible on an equal population. The population of these regions in 1860 was as follows:

EASTERN—1860.		WESTERN—1860.		SOUTHERN—1860.	
State.	Population.	State.	Population.	State.	Population.
Maine	628,279	Michigan	749,113	Virginia } West Virginia }	1,596,318
New Hampshire	326,073	Indiana	1,350,428	North Carolina	992,622
Vermont	315,098	Illinois	1,711,951	South Carolina	703,708
Massachusetts	1,231,098	Wisconsin	775,881	Georgia	1,057,286
Rhode Island	174,620	Minnesota	172,023	Florida	140,424
Connecticut	460,147	Iowa	674,913	Alabama	964,201
New York	3,880,735	Missouri	1,182,012	Mississippi	791,305
New Jersey	672,035	Kansas	107,206	Louisiana	708,002
Pennsylvania	2,906,215	Nebraska	28,841	Texas	604,215
				Arkansas	435,450
				Kentucky	1,155,684
				Tennessee	1,109,801
Total	10,594,300	Total	6,752,368	Total	10,259,016

In 1860 the nine Eastern States had a population of 10,594,300; the nine Western States a population of 6,752,368; and the thirteen Southern States 10,259,016. In the following table, representing the respective population of the same States at the present time, I have used the latest State census as far as possible. In States where no census reports have been taken since the United States census of 1870, the figures are based on estimates made by Mr. Elliott (one of our ablest statisticians) in the Statistical Atlas of the United States:

EASTERN STATES.		WESTERN STATES.		SOUTHERN STATES.	
State.	Population.	State.	Population.	State.	Population.
Maine	650,000	Michigan	1,500,000	Virginia	1,300,000
New Hampshire	320,000	Indiana	2,040,000	West Virginia	500,000
Vermont	330,000	Illinois	3,500,000	North Carolina	1,170,000
Massachusetts	1,821,000	Wisconsin	1,400,000	South Carolina	950,000
Rhode Island	300,000	Minnesota	765,000	Georgia	1,875,000
Connecticut	630,000	Iowa	1,700,000	Florida	250,000
New York	4,995,000	Missouri	2,400,000	Alabama	1,150,000
New Jersey	1,132,000	Kansas	850,000	Mississippi	1,000,000
Pennsylvania	4,125,000	Nebraska	500,000	Louisiana	1,000,000
				Texas	2,000,000
				Arkansas	700,000
				Kentucky	1,500,000
				Tennessee	1,400,000
Total	14,303,000	Total	14,655,000	Total	14,295,000

The growth of the population of the Western States in 19 years has been 7,902,632; that of the Southern States, 4,035,984; that of the Eastern States, 3,808,706—the increase in population in the nine Western States being nearly 8,000,000, or equal to the aggregate increase of the Eastern and Southern States in the same period.

Now let us compare the actual number of hands employed in manufacturing in the Eastern, Southern, and Western States in the years 1850, 1860, 1870, and estimate, from the best data at hand, the probable number engaged in manufacturing at the present time. First, I present a very carefully prepared table, showing the number engaged in manufacturing in the Eastern States in 1850 and 1860, and the rate per cent. of increase in the decade; also, the number engaged in manufacturing pursuits in 1870, the rate per cent. of increase between 1860 and 1870, and the average rate of increase for the 20 years. If we accept for granted that the increase between 1870 and 1880 will be at the same average rate as for the two decades preceding it, a very fair estimate of the probable numerical increase for the decade ending 1880 can be made, and the probable number of persons at present engaged in manufacturing fairly approximated. All the tables have been prepared in the same manner and are verified, and I think as near correct as it is possible to make such estimates:

EASTERN STATES—NUMBER ENGAGED IN MANUFACTURING.

State.	Number engaged in Manufacturing, 1850.	Number engaged in Manufacturing, 1860.	Rate per cent. of Increase.	Number engaged in Manufacturing, 1870.	Rate per cent. of Increase.	Average rate per cent. of Increase for 20 Years.	Probable Numerical Increase for Decade ending 1880.	Probable Number engaged in Manufacturing in 1880.
Maine	28,020	34,619	24	49,180	42	33	16,229	65,409
New Hampshire	27,092	32,340	19	49,783	26	22	8,972	49,755
Vermont	8,445	10,497	24	18,686	78	51	9,529	28,215
Massachusetts	177,461	217,421	22	279,380	28	25	69,845	349,225
Rhode Island	20,967	32,490	55	49,417	52	53	26,191	75,608
Connecticut	50,731	64,469	27	89,523	39	33	29,542	119,066
New York	199,349	230,112	15	351,800	53	34	119,612	471,412
New Jersey	37,830	56,027	48	75,552	35	41	30,976	106,528
Pennsylvania	146,766	222,132	51	319,487	43	47	150,159	469,645
	696,661	900,107		1,273,808			461,055	1,734,863

The facts here brought to light corroborate the statement heretofore made that the Eastern States are steadily and healthily growing. Both in 1860 and 1870 the percentage of growth in Rhode Island was greater than that of any other Eastern State, rising to 55 and 52 per cent.; the lowest was the State of New York. Next is presented the exhibit of the West:

WESTERN STATES—NUMBER ENGAGED IN MANUFACTURING.

State.	Number engaged in Manufacturing, 1850.	Number engaged in Manufacturing, 1860.	Rate per cent. of Increase.	Number engaged in Manufacturing, 1870.	Rate per cent. of Increase.	Average rate per cent. of Increase for 20 Years.	Probable Numerical Increase for Decade ending 1880.	Probable Number engaged in Manufacturing in 1880.
Michigan	9,344	23,190	148	63,694	175	161	102,547	166,241
Indiana	14,440	21,295	47	58,852	176	112	65,914	124,766
Illinois	11,559	22,964	99	82,979	261	180	149,362	232,341
Wisconsin	6,089	15,414	153	43,910	185	169	74,207	118,117
Minnesota	.....	2,123	....	11,290	432	......	48,773	60,063
Iowa	1,707	6,307	269	25,032	297	283	70,840	95,872
Missouri	15,808	19,681	24	65,354	232	128	83,653	149,007
Kansas	....	1,735	....	6,844	294	.....	20,121	26,965
Nebraska	....	336	....	2,666	693	......	18,475	21,141
	58,947	113,045		360,621			633,892	994,512

The steady growth of the manufacturing interests of the Eastern States seems tame when compared with the rate of increase in the Western States, whither the population drifts in following the "lines of least resistance." The lowest rate of increase (Michigan) is 175 per cent., which runs up as high as nearly 700 per cent. in the new State of Nebraska. In 1850 only 58,947 were engaged in the Western States in manufacturing operations; at the present time, according to this estimate, not less than 994,512 are employed. Lastly, the Southern exhibit is given:

SOUTHERN STATES—NUMBER ENGAGED IN MANUFACTURING.

State.	Number engaged in Manufacturing, 1850.	Number engaged in Manufacturing, 1860.	Rate per cent. of Increase.	Number engaged in Manufacturing, 1870.	Rate per cent. of Increase.	Average rate per cent. of Increase for 20 Years.	Probable Numerical Increase for Decade ending 1880.	Probable Number engaged in Manufacturing in 1880.
Virginia	29,110	36,174	24	26,974	—34	—5	—1,349	25,626
West Virginia	....	....	...	11,672	....	...	....	....
North Carolina	14,601	14,217	—3	13,622	—4	—3	—408	13,214
South Carolina	7,066	6,994	—1	8,141	16	7	569	8,710
Georgia	8,368	11,575	38	17,871	54	46	8,220	26,091
Florida	991	2,454	148	2,749	12	80	2,199	4,948
Alabama	4,936	7,889	60	8,248	4	32	2,639	10,887
Mississippi	3,154	4,775	51	5,941	24	37	2,198	8,139
Louisiana	6,217	8,789	41	30,071	242	141	42,400	72,471
Texas	1,066	3,449	223	7,927	130	176	13,951	21,878
Arkansas	842	1,877	123	3,206	71	97	3,109	6,315
Kentucky	21,476	21,258	—1	30,636	44	21	6,433	37,069
Tennessee	12,039	12,528	4	19,412	55	29	5,629	25,041
	109,866	181,979		186,470			71,919	258,389

The negative sign (—) indicates a decrease of manufacturing population, as in the cases of Virginia and North Carolina.

In the South, as might be expected, the figures reveal a very different story. Still I am inclined to think that the good things already shown about the Southern States may make the real facts in 1880 more pleasant to dwell on than our estimate. With reviving business the South should have 300,000 persons engaged in manufacturing in 1880. The result of the investigation may be thus epitomized:

RECAPITULATION.

State.	Number engaged in Manufacturing, 1850.	Number engaged in Manufacturing, 1860.	Number engaged in Manufacturing, 1870.	Probable Numerical Increase for Decade ending 1880.	Probable Number engaged in Manufacturing in 1880.
Eastern States	696,661	900,107	1,273,808	461,055	1,734,863
Western States	58,947	113,045	360,621	633,892	994,512
Southern States	109,866	131,979	186,470	71,919	258,389

Unfortunately I have not at hand the data to make the same extensive investigation in relation to agricultural occupations. In 1870 the Southern States were far ahead of the Western and Eastern States in this particular, but when we take into consideration the extension of manufactories in the West as compared with the South, the difference is more than made up. Here are the actual figures:*

EASTERN STATES.		WESTERN STATES.		SOUTHERN STATES.	
State.	No. engaged in Farming.	State.	No. engaged in Farming.	State.	No. engaged in Farming.
Maine	82,011	Michigan	187,211	Virginia	244,550
New Hampshire	46,573	Indiana	266,777	West Virginia	73,960
Vermont	57,983	Illinois	376,441	North Carolina	269,238
Massachusetts	72,810	Wisconsin	159,687	South Carolina	206,654
Rhode Island	11,780	Minnesota	75,157	Georgia	336,145
Connecticut	43,653	Iowa	260,263	Florida	42,492
New York	374,323	Missouri	263,918	Alabama	291,628
New Jersey	63,128	Kansas	73,228	Mississippi	259,199
Pennsylvania	260,051	Nebraska	23,115	Louisiana	141,467
				Texas	166,753
				Arkansas	109,310
				Kentucky	261,080
				Tennessee	267,020
Total	1,012,312	Total	1,685,797	Total	2,669,496

* This table is compiled from the U. S. Census of 1870.

It has been shown that the main crops of the South are cotton and tobacco. There was a time when the Southern States cared to produce nothing else, and with the foreign gold those crops brought they could buy the necessaries of life. That day has passed, and the farmers and planters of the Southern States see the advantage of not depending on a single crop. The following table has been prepared from the best official sources:*

States.	Corn.	Wheat.	Oats.	Hay.	Potatoes.
Eastern States......	$47,310,000	$45,318,875	$37,021,000	$144,825,000	$37,090,500
Western States......	235,128,500	206,092,854	46,636,900	80,211,570	24,603,960
Southern States......	157,390,000	55,627,800	19,238,000	13,844,380	5,190,380

The great difference in the value of the products near to and far from the seaboard makes the above comparison rather unfavorable for the West. Below I have prepared a table showing the average yield of corn, wheat, and oats, and also the value per acre in the Eastern, Western, and Southern States:†

States.	Average Yield per Acre. Bushels.			Average Value per Acre.		
	Corn.	Wheat.	Oats.	Corn.	Wheat.	Oats.
Eastern States......	35	17	34·8	$24.05	$24.27	$15.05
Western States......	31·4	15·4	35·8	9.05	15.09	7.92
Southern States......	18·4	9·7	19·1	9.19	11.60	9.88

The highest average yield of wheat is in the Eastern States, where wheat averages 17 bushels to the acre; in the Western States, 15·4; and in the Southern States, only 9·7 bushels. The average value in the Western States of the wheat crop is $9 per acre less than in the Eastern States; corn, $15 an acre less; and oats, $7 less. Lastly, in this connection is given a table showing the value of the oxen, cattle, sheep, and hogs annually produced in the three great geographical divisions of the United States:

States.	Oxen and other Cattle.	Sheep.	Hogs.
Eastern States...	$61,006,452	$14,587,249	$20,552,899
Western States..	121,503,102	17,912,600	68,262,653
Southern States..	90,116,341	17,706,577	52,530,936

The Hon. David A. Wells, in his valuable essay on the "Elements of National Wealth," says:

"Be the value of the annual product what it may, by far the largest proportion of such product must necessarily be consumed as rapidly as produced, in order that the individual constituents of the nation—its men, women, and children—may simply live and make good the loss and waste of capital previously accumulated, leaving but a small fraction of the annual product in the form of surplus, or accumulation, which can be used for effecting future increased production and development."

* Report of the Commissioner of Agriculture for 1878.

† This statement is based on the Reports of 1877.

The progress of a nation does not depend on what it has accumulated, but on the continuity of those processes and resources by which the wealth was won in the first place. In this, as our tables abundantly prove, the nine Western States stand pre-eminently ahead. The greatest wealth, the highest prosperity, is achieved where the two great occupations are the most equally divided. We have seen the dangers of an excessive development of manufacturing interests in England, and a neglect of agriculture; we have seen the evil effects of the other extreme in the Southern States. Each of the great geographical sections of our country may profit by the few facts herewith presented. The Eastern States have already awakened to the necessity of more scientific farming. The rapid increase in number of those engaged in manufacturing occupations in the nine Western States shows that every year the two great industries are becoming more evenly distributed in the West. In its eagerness to compete with the Eastern States the West should not forget that the foundation of its strength lies in its food-producing powers. Cheap food as well as cheap products of the mill and shop should be the aim. These comparative statements aid greatly in studying the nation as a whole. It is only by such a study that we may hope to find out its strength and weakness, its success and failure. It is from such a view of our wants that all of us gain common sense, common aims, and a deeper faith in the future of the Republic.

Robert P. Porter.

AN ATTEMPT AT A SYSTEMATIC CLASSIFICATION OF THE VARIOUS FORMS OF ENERGY.*

By Dr. O. J. Lodge.

1. Every action which takes place between two bodies† is of the nature of a *stress*. A stress consists of two equal opposite forces (called action and reaction, or force and anti-force), one of them exerted by the one body, and the other by the other; and it is impossible for one force to be exerted without the other.

2. Whenever a body exerting a force moves in the sense of the force it exerts, it is said to do *work*;‡ and whenever a body exerting a force moves in the sense opposite to that of the force it exerts, it is said to have work done upon it, or to do anti-work, the quantity of the work being measured in each case by the product of the force into the distance moved through in its own direction.

3. Whenever two bodies exert a stress on each other, they are in contact; and if they move, they move together over the same distance;§ hence, since the force equals the anti-force, the work done by the one in any movement is equal to the anti-work done by the other.

4. The working power‖ of a body is measured by the average force it can exert, multiplied by the *range* or distance through which it can exert it. The working power of a body may be increased or diminished by increasing or diminishing either the force or its range, or both; and it must remain dormant so long as external circumstances do not allow it to exert a force through a distance.

5. Whenever work is done *upon* a body, an effect is produced in it, which is found to increase the working power of that body (by an amount not greater than the work done); hence this effect is called *energy*, and it is measured by the quantity of work done in producing it.¶ Whenever work is done *by* a body, *i.e.*, anti-work done on it, its working power is found to be diminished (to at least the extent of the work done), and it is said to have lost energy—the energy lost being measured, as before, by the anti-work done in destroying it.

6. But in every action taking place between two bodies the work is equal to the anti-work (§ 3); hence the energy gained by the first body is equal to the energy lost by the second; or, on the whole, energy is neither produced nor destroyed, but is simply transferred from the second body to the first. (Remember foot note to § 1.)

To summarize then: Work creates energy; anti-work destroys it; so both together simply transfer it. Or, in other words, the transference of energy requires a stress to act through a distance, and involves therefore two equal opposite works. If it were possible to obtain a force without its anti-force, or if it were possible for two bodies exerting stress on one another to move over unequal distances (§ 3), when it would be possible to obtain work without the anti-work, and thus to get a source of new energy (technically called the perpetual motion); but, as a fact of experience, it is not possible.

7. When work is done upon a body, different kinds of effects can be produced, depending both on the nature of the body and on the way in which the forces doing the work are applied to it; and these constitute the different *forms* of energy.

* From the *Philosophical Magazine*.

† The term *body* is here used in its most general sense, viz., as standing for a piece of matter in general, without regard to size. It may mean a planet or an atom; and it may even apply to such extra-material things as the ether and the hypothetical ultra-mundane corpuscles, or to anything else which is sufficiently like ordinary matter to be capable of possessing energy and of doing work therewith.

‡ It seems preferable to speak of the work as being done by the *body* rather than by *force*; though the latter expression is undoubtedly convenient sometimes.

§ This step is rendered necessary by the preceding one of considering the work as done by the *body*. If it is the force which does the work, it is unnecessary.

‖ Or power of doing work. But either term is objectionable, because *power* means *rate of doing work*. The term entropy has been used, but I believe that the accepted connotation of this word is now different.

¶ This definition of energy, as the effect produced in a body by an act of work, is not so simple as the usual one—"the power of doing work;" but this latter definition seems a little unhappy. For energy is power of doing work in precisely the same sense as capital is the power of buying goods. Now a sovereign has an infinite power of buying goods if it has any at all—twenty shillings worth being bought whenever it is transferred from one man to another. The proper statement is that a sovereign usually *confers upon the man that possesses it* a certain buying power, which power he loses when he has transferred it; and in this sense money is a power of buying goods. It does not, however, *necessarily* confer upon its owner any buying power, because there may not be any accessible person to buy from; and if there be, he may have nothing to sell. Just so with energy: it usually, though not necessarily (see § 14), confers upon the body possessing it a certain power of doing work, which power it loses when it has transferred it. The analogy here indicated will be found useful in teaching.

Energy corresponds to capital.
Doing work corresponds to buying.
Doing anti-work corresponds to selling.

The transfer of capital is accompanied by two equal opposite acts, buying and selling; and it is impossible for one to go on without the other. Hence the algebraic sum of all the buying in the world is always zero: this is the law of the conservation of capital.

8. We can proceed to classify the forms of energy by first of all considering how the effects produced depend upon the forces applied to the body.

If these forces have no resultant (*i. e.*, if they are in equilibrium), the body will be *strained*, and will exert a corresponding stress.

If the forces have a resultant, the body will be *moved*;* and the motion will be either a translation or a rotation, or both, according as the forces can be reduced to a single finite resultant, a resultant zero at infinity, or to both combined.

Similarly, the strain may be analyzed into compression, elongation, and shear, or a combination of them, according to the way the forces act; but this division does not appear to be of much use for our present purpose.

All these effects are forms of energy, because the working power of the body in which they are produced is in general increased; *i.e.*, the body is rendered capable of doing work as soon as the proper condition is supplied. (See § 4.)

Thus a steadily strained elastic body is exerting force or pressure; but its point of application is stationary: allow it to move, and work is immediately done. A body in free motion is passing through space, but it is not exerting any force; supply a resistance, and work is immediately done.

9. Energy, therefore, has two principal forms:

(1) The free motion of bodies relatively to one another.

(2) The separation of bodies from one another against stress.

And to these may be added for convenience the rapid alternation from one form to the other, called vibration.

10. The two fundamental forms of energy correspond to the two factors in the produce work.† A body exerting force possesses energy, and a body moving through space possesses energy; but a body is not doing work unless it is *both* exerting force *and* moving through space.

The energy possessed by matter in motion is called *kinetic*. The energy possessed by matter exerting force is called *potential*. It might with great propriety be called *dynamic* energy; and it has been very conveniently called *static* energy,‡ in opposition to kinetic. Of the two factors, F and *s*, then, in the product work, kinetic energy corresponds to *s*; there is motion through space, but no force: potential energy corresponds to F; there is force, but no motion.

11. Whenever work is being done, both factors must be present—that is, both kinetic and potential energy; and the energy is always passing from one of these forms into the other while the work is being done. For if the motion of a body is *with* the force which acts upon it, its speed must increase; and if the motion is *against* the force, the speed must decrease; while in the first case the available distance through which the force can act, or the *range* of the force, is decreasing, in the second increasing.

12. The groups into which the forms of energy have been arranged (§ 8)—viz., strain, rotation, translation, and vibration—may now be subdivided further, by considering how the effects produced when work is done upon a body depend upon its nature and size.

A convenient division of bodies, according to size, will be:

1st. Masses comparable in size with the human body, which may be called ordinary masses.

2d. Masses incomparably larger, as planets.

3d. Masses incomparably smaller, as particles or molecules.

4th. The ultimate atoms.

All these material bodies agree in general properties, and differ only in size. But distinct apparently from these there exists an unknown *something*, which is material enough to be capable of possessing energy, to disturbances in which electrical phenomena seem to be due, and of which probably an aspect has been called ether. This must therefore constitute a 5th group, differing from the others apparently in respect of nature, not of size.

13. All these groups of bodies may be strained or set in motion in various ways when work is done upon them; and the groups into which the known forms of energy are thus thrown are exhibited provisionally in the table on next page.

It is quite possible that the form of energy indicated in compartment No. 4 would be better placed in No. 8, those now in No. 8 being placed in No. 12; but I have placed them as they now stand because they are closely connected with the vibration forms in the same rows. Moreover the true position of gravitation energy cannot be properly defined till we know more about it. It may have to come under the kinetic head—the motion of Le Sage's corpuscles.

Probably the arrangement of the forms in the last row may be improved, but I am not sufficiently acquainted with the Maxwellian theory to do it. Neither do I know whether one is justified in pointing out an analogy between the two forms of strain indicated in No. 20 and simple and torsional shear—or whether one may imagine that the volume elasticity and Young's modulus of the "something" are infinite, but that its rigidity is finite though high. An apparently consistent, though rather hazy mental image of some obscure phenomena, may be built up on a basis like this; but it is too speculative to be mentioned further here.

14. The power of doing work conferred upon a body by the possession of energy does not depend upon the absolute quantity of that energy only, but on its transferability. If it is not transferable, the body possessing it has no power of doing work.

15. Energy which can be guided, and all, or nearly all, transferred to any body at pleasure, is called a high or available form of energy, and is said to be capable of doing "useful" work, this work being done every time it is transferred in desired directions.

Energy which is nearly incapable of being guided, and which transfers itself in directions not required, is called a

* And possibly strained as well. It is only forces which, like gravity, act uniformly on every particle of a body, that can move an ordinary elastic solid without straining it.

† Energy and work are not to be confounded together; and all such phrases as "accumulated work," "conservation of work," "conversion of heat into work," "work consumed," etc., should be eschewed. Energy is not work, but work can be got out of it if the proper condition be supplied. It is, in fact, *possible* work.

The expression *possible energy*, however, is meaningless; so also is the expression *actual* energy. All energy is *actual* and *real*—potential just as much as kinetic; and all represents possible *work*—that is, work that will become actual as soon as the other factor is supplied.

‡ The *cause* of the stress exerted by a strained body in any particular case is not in general known, and it may easily turn out often to be ultimately due to a kinetic phenomenon, as it certainly is in the case of the stress exerted by a compressed gas; nevertheless it may still be called static energy so long as the cause of the stress is not under consideration.

low or unavailable form of energy; and the work done at each of its undesired transfers is called "useless" work.*

16. The distinction between high and low forms of energy is a relative one, and depends on our present power of dealing with matter.

Masses of matter comparable to our own bodies in size can be handled and dealt with singly; and so they can in general be caused to do work upon, and therefore transfer their energy at pleasure to, any of the numerous accessible bodies which are competent to receive it. Hence energy possessed by them is generally of a high form.

17. Planetary masses can be dealt with singly indeed, but so singly that there is scarcely† any other body accessible to which their motion can be transferred.‡ (See §§ 4 and 14.)

18. The energy of moving molecules is not very available to us, because we can only deal with them statistically and not individually. There is a large amount of relative motion and transference of energy constantly going on among individual molecules; but, as we have no control over it, the work done is useless, and the energy unavailable. The only part of the energy which can be transferred at will to external bodies is that due to the *average* state of the moving molecules; and it is not possible to transfer even this unless some other mass is accessible, the average state of whose molecules in respect of motion or strain is in some way different, so that the one is able to do work upon the other.§

Bodies.	Energy of Motion, or Kinetic Energy.		Energy alternately kinetic and potential.	Energy of stress, or potential energy.
	Rotation.	*Translation.*	*Vibration.*	*Strain, etc*
Planetary masses.	1. *E. g.* Earth's diurnal motion.	2. *E. g.* Earth's annual motion.	3. *E. g.* The moon's libration. Tides. Pendulums.	4. Energy of gravitation. *E.g.* A head of water. A raised weight.
Ordinary masses.	5. *E. g.* Fly-wheel.	6. *E. g.* Cannon-ball. Rivers.	7. Sound-vibrations. *E.g* Tuning-fork.	8. Energy of strained elastic bodies. *E.g* Watch-springs.
Particles or molecules.	9. Part of the heat-energy of fluids.	10. Most of the heat-energy of gases.	11. Heat-energy of solids.	12. Energy of molecular stresses. *E.g.* "Internal work."
Atoms.	13. Unknown motions which take place during the act of chemical combination and during dissociation.	14. The translation of atoms is observed in electrolysis.	15. The period of atomic vibration is observed by the spectroscope.	16. Energy of chemical affinity.
Something.	17. Magnetism.	18. Electric currents.	19. (1) Discharge of accumulators. (2) Radiation.	20. 1) Electrostatic stress. (2) Electro-magnetic stress.

[The numbers in the compartments are merely for convenience of reference.]

Now, since all accessible bodies have very large stores of molecular energy, it follows that a very great portion of the energy which belongs to the molecules of a body must be totally unavailable to us, because it can never be got rid of or transferred. And even the portion which can be transferred at pleasure to some larger body, if not made use of quickly, will be found to transfer itself to neighboring molecules and in directions not required, and will waste itself in doing useless work. Hence molecular energy is called a low form.

19. Atomic or chemical energy seems at present to rank a little higher than molecular energy, for though one way of availing ourselves of it is by converting it into molecular energy (heat), and then doing useful work with the balance of the average effect by which the body heated excels its neighbors, yet animals and galvanic batteries are able to do useful work with it in a more direct and less wasteful fashion.

The unknown or electrical energy appears to rank distinctly above the energy of molecules, because we have found some remarkable and indirect means of transferring the energy of electric currents to ordinary masses by the intervention of electro-magnetism with a comparatively small waste.

20. When energy passes from a higher to a lower form it is said to be *degraded*, and when it has no availability at all it is called *dissipated*.‖

Energy is degraded when it is transferred from masses of ordinary size to the molecules of which they or others consist (§ 18).

The two fundamental forms of energy are those due to motion and those due to strain (§ 9). Now, whenever motion takes place against friction, some energy is always transferred to the molecules of the rubbing surfaces; and whenever strain is produced in imperfectly elastic bodies, some energy always passes to the molecules.

But in practice no motion takes place without friction; and all bodies are imperfectly elastic. Hence energy is continually getting dissipated; or, in other words, at every transfer of energy between ordinary bodies under ordinary circumstances, some of it is always and necessarily degraded into a lower and less available form.*

* The distinction between useful and useless work is quite accidental, and belongs more to economics than to physics. An engineer will often degrade the whole of a large quantity of energy in order to produce some superficial result which he happens to desire at the moment, *e. g.*, when a planing machine smooths a surface; or when a locomotive transfers passengers or goods between places on the same level.

† The well-known exception is the ocean, which by the agency of the moon is put into a slightly different state of motion from the rest of the earth; and a minute portion of the earth's energy of rotation is constantly being transferred to it. A portion of this tidal energy is now available to us, and may be made to do useful work.

‡ Hence the kinetic energy of the earth is of no more use to us than a bank-note to Robinson Crusoe.

§ An analogy may be drawn between the molecular energy of a body and the money of a bank, of which a reserve fund is kept for internal transfer and transactions between customers, while the excess gets invested in external concerns which have a deficiency, and so becomes available for doing useful work. To make the analogy more complete, the clerks should be uniformly dishonest, or the coffers insecure, so that stored money should dribble away.

‖ It is then of no more use to us than is our money to the inhabitants of Mars, who have no means of getting at it. Its terrestrial transferences are to them useless.

It may be useful to append the following summary of the contents of the sections: 1. Newton's third law. 2. Definition of work, + and —. 3. Denial of "action at a distance." 4. Definition of working power. 5. Definition of energy. 6. Conservation of energy, and first law of thermodynamics. 7. Possibility of various forms of energy. 8. Classification of the forms of energy. 9. The fundamental forms of energy. 10. Kinetic and potential energy are related to the two factors in the product work. 11. Transformation from one form to the other. 12. Further subdivision of the forms of energy. 13. Classification table.

14. Distinction between energy and what was once called entropy. 15. Distinction between available and unavailable energy, and between useful and useless work. 16. Reason why the energy of ordinary masses is available. 17. Reason why planetary energy is almost unavailable. 18. Reasons why molecular energy is much of it unavailable, and second law of thermodynamics. 19. Extent of availability of atomic and of electrical energy. 20. Dissipation of energy.

* For instance, during every quarter-swing of a free pendulum, energy is being transformed from kinetic to potential, or *vice versa*; and is being transferred from the unknown gravitation agent to the mass of the pendulum, or back again. Some, however, is dissipated every time, and ultimately the pendulum must stop.

CORET'S METALLIC THERMOMETERS.

M. CORET's metallic thermometers consist of an arrangement of tubes of different metals (zinc and iron or copper and steel, for example) placed parallel to each other and soldered together at their ends so as to form a series in which

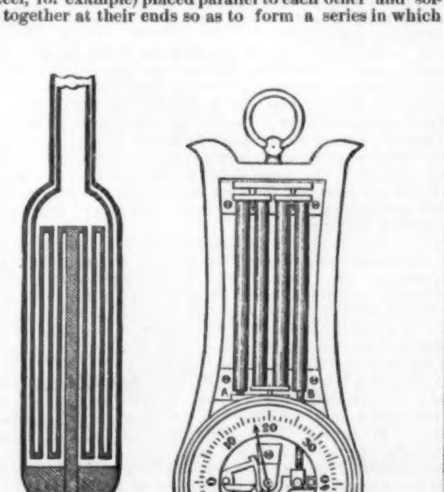


FIG. 2.

CORET'S METALLIC THERMOMETERS.

the differences of expansion between two consecutive tubes are added as many times as there are pairs employed. Fig. 1 shows one of the arrangements adopted by the inventor, and represents the lower portion of the plunging rod of a thermometer designed for ascertaining the temperature of liquids. The motion of the final and middle tube is sufficient, if further increased by a toothed wheel, to move the needle of a graduated scale. This part of the system is not represented in Fig. 1. Fig. 2 gives the general arrangement of a new style of thermometer constructed by M. Coret. The mechanism and the tubes which form the thermometric apparatus are fixed to the same plate, and set in a wooden lyre-shaped frame. The thermic apparatus is fitted to the plate at the point, A; the extremity, B, is connected with a lever which actuates the toothed sector that serves to move the index needle.

The cheapness with which the apparatus can be constructed and their very great sensitiveness are the two advantages claimed for this system.

BREAKING HORSES BY ELECTRICITY.

DIFFERENT methods have often been proposed for stopping and controlling mettlesome or restive horses, but there is none more ingenious and more efficacious than the one

A GALLOPING HORSE SUDDENLY BROUGHT TO A STAND-STILL BY THE ACTION OF THE ELECTRIC BIT.

invented by M. Defoy, and the advantages of which have recently been brought to the notice of the Société d'Encouragement by M. Bella, the Superintendent of the Omnibus Company of Paris. The system consists simply in the use of small Clark apparatus contained in a box, which can be easily placed under control of the coachman or rider. In the interior of the reins is a metallic conducting wire, terminating at one end in the bit, and at the other in the magneto-electric apparatus. By turning the crank of the electro-magnet a current is induced which, acting on the mouth of the horse, so surprises him that he stops and remains passive. By joining a few kind words to the action of the electricity, the most dangerous horse is quickly mastered. M. Bella reports that M. Defoy has experimented with the apparatus in his presence, at the depot of the Omnibus Company, where are collected together some of the most vicious and dangerous of horses. A Hungarian horse, which was very difficult to shoe, was led to the smithy and there became very vicious, whereupon the electric reins were applied. After a few moments of experimenting he allowed himself to be patted on the back and shoulders, then he permitted his legs to be touched, and finally his hind feet to be raised—the latter being something that had always been difficult to accomplish.

The smith struck one of his hoofs without causing him to rebel, and then his shoes were changed without the necessity of fettering him, and without his resuming his dangerous efforts at resistance. The Superintendent of the Parisian Cab Company has also recently borne witness to the efficacy of this process. "The experiment," says M. Camille in his report, "was made on several horses which, until then, it had been impossible to shoe; but all without exception submitted to the operation under the influence of the electrical apparatus. One horse that was to be shod went so far as to lie down and roll over and over on the ground, all the while struggling, defending himself, and fighting against everything; nothing could subdue him. I then had recourse to M. Defoy's apparatus, and, on the first trial, much to my surprise, the feet of the intractable horse were lifted without any great difficulty, and on the second trial it was as easy to shoe him as if he had never made the least resistance; the animal was conquered."

M. Defoy has recently brought before us, says the editor of *La Nature*, a dangerous horse which, after putting him to the gallop, he brought to a sudden stand-still by turning the crank of the Clark apparatus placed on the seat of the carriage (see engraving). It should be remarked that the result is not obtained by means of a violent shock; for the electric current is not strong enough to benumb the animal, but only sufficiently so to produce a sort of astonishment, and the disagreeable (although not painful) pricking sensation peculiar to electricity. As a complement to his electric bit, M. Defoy has recently brought out what he styles an electric "stick," and which is no less ingenious than the former. This is a riding whip containing two conducting wires, insulated from each other by leather, and terminating in two points placed perpendicular to the end of the "stick." As in the former case, the other ends are connected with a magneto-electric apparatus. If a horse is in the habit of rearing, it is only necessary to urge him with the feet, at the same time applying the points of the electric "stick" to his shoulders, when he will at once move forward with head

downward. The same success will be had with a horse accustomed to wheel about.

The current applied to his face, on the side towards which he is about to turn, will at once stop him. By the aid of this little apparatus, M. Defoy causes a horse to obey in a few moments all his wishes. This new process is a great improvement over the barbarous methods of breaking horses hitherto in vogue, and appears, from all accounts that we have of it, destined to render great services.

REYNIER'S NEW INCANDESCENT ELECTRIC LAMP.

As is well known, the principle of Mr. Reynier's electric lamp consists in making a slender carbon rod incandescent by means of an electric current that traverses a limited part of the rod, between a head contact and carbon holder in which the carbon glides forward.

Mr. Reynier has continually simplified his lamp until he has arrived at the novel arrangement shown in the annexed cuts.

The carbon, C, is pushed in the direction of the arrow by some suitable mechanism, and abuts against the end contact, B; the contact is mounted in the end of a lever held against the carbon, C, by a spring, r, and confines the incandescence of the carbon rod, C, to the space between i and j.

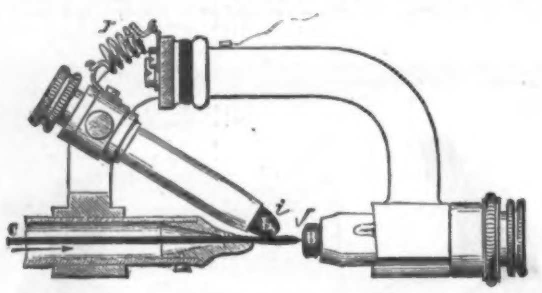


FIG. 1.—THE REYNIER ELECTRIC LAMP.

The end contact, B, is mounted in a carbon holder on a curved arm in the lower part of the lamp.

In order to introduce the carbon rod into the lamp the carbon holder is removed, the carbon, C, is placed into its tube, the carbon holder is replaced, and the lamp is ready for operation.

The incandescence shows itself, as we have said, between i and j, and varies in length from 0·16 to 0·31 of an inch. The light obtained is equal to that of 5 to 20 Carcel lamps, according to the intensity of the electric current and the length of the incandescent part of the carbon. With a pile of 8 Bunsen plates (Ruhmkorff model) a light equal to about 12 Carcel lamps can be obtained.

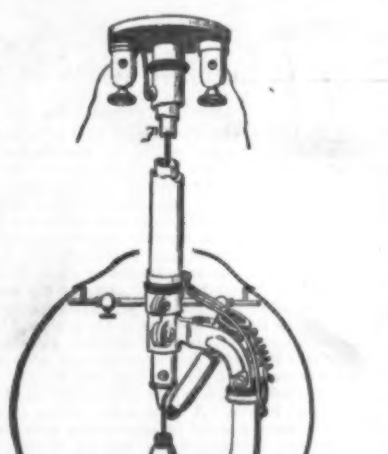


FIG. 2.—THE REYNIER ELECTRIC LAMP.

If magneto-electric machines are used, 3 to 5 lights, each equal to 8 to 14 Carcel lamps, can be obtained per horse power, thus giving a production of 30 to 40 Carcel lamps per horse power.

Mr. Reynier has devised several variations of his lamp, and actuates the carbon rod by means of a hydrostatic mechanism or by counterweights, a moving barrel, which operates in all positions, and the suspended apparatus, which is the most simple of all, and is shown in Fig. 2. In this case the movement of the carbon is obtained by the descent of the cylinder, p, which acts directly upon the end of the carbon.—*La Nature.*

ELECTRIC ILLUMINATION.

By M. TOMMASI.

THE author points out the disadvantages both of the Bunsen battery and of the dynamo-electric machine as employed for the production of the electric light, and proposes a new battery—a modification of that of Bunsen—which can be worked at 7 centimes per hour per element, whilst a similar intensity, obtained with the dynamo-electric machine costs 19 centimes. The maintenance of 10 burners with the common Bunsen battery costs 50 centimes per hour; with the magneto-electric machine 25 centimes, and with the Tommasi battery 13 centimes. An equal light produced by means of gas at 30 centimes per cubic meter would cost 42 centimes.

ASPERGILLUS IN THE LIVING HUMAN EAR.*

By CHARLES HENRY BURNETT, M.D., Philadelphia.

MY apology for presenting this paper must be that clinical observations are always of value, whether they are confirmatory of the researches of others, or expository of the features of a disease and of simpler modes of treatment.

Although many of the readers of this account of the growth of a fungus in the ear—and I use the word fungus in purely a botanical sense—will be familiar with the literature pertaining to the subject, it will not be out of place to recall some of it, both to refresh our memory and to help those who have not had access to works setting forth the nature of this parasite as it shows itself in the living human ear.

It is to Wreden, of St. Petersburg, that the profession looks for the most voluminous account of the growth of this fungus in the ear, and of the aural disease produced by it, to which Wreden has given the very appropriate name of *Myringomycosis aspergillina.*

The first observations of the growth of a fungus in living animal tissues were made by German and French writers, in the first half of this century, according to the work of Wreden already alluded to. These writers based their statements on what they found in the lungs and air-vesicles of birds. Virchow too observed fungi, perhaps the aspergillus, growing in the lungs of man.

The first proof of the development of fungi in the ear of living man was given by Mayer, and subsequently by Paccini; still later by Carl Cramer and Schwartze. It is highly probable that the cases thus reported were of aspergillus. Wreden's first article on the subject appeared a year later than Schwartze's, and gave an account of six cases of the growth of aspergillus in the human ear. The species found were characterized by him as of the *A. glaucus*, Lk.

Then followed communications on this subject from numerous sources in Germany and in the United States. In the former country from Von Troeltsch, Böke, A. Politzer, J. Gruber, Weber-Liel, Bezold, Lucae, Nölting, and others; and in our own land, from J. Orne Green, Roosa, C. J. Blake, and myself.

The vast majority of these communications have related to the aspergillus, although there have been some interesting exceptions which appear worthy of mention here.

Hassenstein and Hallier claim to have found in the ear of man the *Graphium penicilloides;* Von Troeltsch, the *Ascophora elegans;* Schwartze and Steudener, the *Tricothecium;* Böke, the *Mucor mucedo seu fuscus;* and Blake, a bastard form of *Penicillium.* Wreden, in one instance, found the most fully developed or ascomycete form of the *Aspergillus nigricans*, which from its intense purplish color he called, for the time, the *Otomyces purpureus*, but which on examination was not found to be a separate species of aspergillus; and Dr. J. Orne Green has described a form of *Aspergillus rubens*, in which the fungus was, as indicated by the name given it, of a red color.

But all of these forms of fungus are of unfrequent occurrence, and would by their bluish or purplish color easily attract attention and at once indicate their nature as not that of ordinary aspergillus.

The Aspergillei belong to the division of the fungi called Arthrospores. In the same division are other fungi which at times become parasites of living man, viz.: the Tricophyton, the Microsporon, the Achorion, and the Oidium.

The Aspergillei form a family by themselves, according to Léveillé, having, according to Charles Robin, eight species. Some of these species have been found in tuberculous lung, notably in the lungs of birds, though also in that of man. To us, however, the most interesting species are those found growing in the auditory canal, and on the membrana tympani of living man.

This is no uncommon occurrence, yet doubtless it is not usually recognized, although exciting an inflammation of a decidedly peculiar form. Even the late Mr. James Hinton, of London, stated that he had not met it in his enormous practice, and doubted its existence in denizens of cities.

Dr. J. Patterson Cassells, of Scotland, is the only British writer on the observation of the growth of this fungus in the ear of living human beings.

Aspergillus is a form of mould, and shows a decided tendency to grow in the ear of man. It is believed by some to be ordinary mould modified by growing in living human tissue. It is not, however, identical, either macroscopically or microscopically, with the ordinary blue or green mould. From my observations I am inclined to believe that the Aspergillus found in the ear of living man is, as Wreden has termed it, the specific aural fungus. One thing seems fully settled; that the fungus is not found anywhere else in forms similar to those which flourish in the ear both of the lower animals and of man.

Two forms have been found in the ear of man, and have been called the *A. glaucus* and the *A. nigricans.* But these terms do not recommend themselves as apt, because the color of the fructiferous hyphens, on which these names are based, is neither invariable nor decided enough to render this nomenclature distinctive.

It seems to me that the terms *major* and *minor* would be preferable to *nigricans* and *glaucus* respectively. Here let me say I am speaking simply as a diagnostician of aural disease, and not as a botanist or mycologist.

The so-called *A. nigricans* is by far the more common in its occurrence in the ear of man, and is larger in size than the *A. glaucus*, which is rarely found in the ear. As will be seen by referring to the cases I present, the *A. nigricans* was found in all.

* Abstract from the *American Journal of Otology.*

These forms are easily distinguished from each other by the shape of their fruit heads and the arrangement of the sterigmata thereon, and on these differences I would like to base their nomenclature. So far as their color is concerned, it is wholly unreliable as a diagnostic difference; in no instance is their color either clearly green or black. In all cases of ordinary aspergillus the color is yellowish or brownish. It has never been shown that one form excites an inflammation different from that produced by the other; but it may yet be shown to be of the highest importance in diagnosis to have for these fungi a definite name, for in whatever form they manifest themselves in the ear they excite a stubborn and painful disease.

For the sake of uniformity and order, I shall retain the names *A. nigricans* for the *larger*, and *A. glaucus* for the *smaller* species.

Microscopic features.—The microscopic features of the growth of this parasite in the human ear are varied and full of interest. If a small piece of a colony of *Aspergillus nigricans*, in the earliest stages of its development, be examined

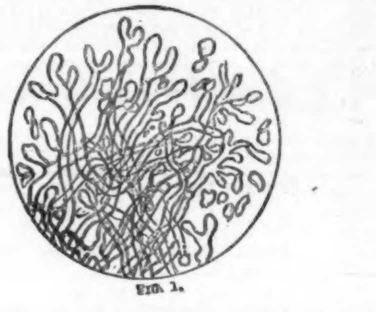


FIG. 1.

under the microscope with a power varying from 250 to 300 diameters, a field similar to that in Fig. 1 will be observed. It is in fact the first formation of rootlets or the mycelial web from which, at a later period, the fruit stalks or fructiferous hyphens spring. It will also be seen that some of the filaments composing the web tend to become bulbous at one end, and that the latter, as the stem grows, becomes larger and dotted (Fig. 2), until finally there is standing out from the dense web of mycelial filaments a perfect fruit stalk and a fructiferous head—the latter studded with short peg-like limbs, the sterigmata, on the free ends of which are the spores. (Fig. 3, B.)

All of these stages of growth I have traced in specimens of the fungus removed from the human ear. In the fluid

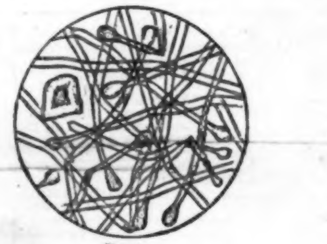


FIG. 2.

parts of the specimen, epithelium may usually be seen in small quantities, as the parasite develops, as in the upper part of Fig. 2.

Very rapidly, in the course of a day or two at most, the perfect fruit stalk is formed in large numbers and in all stages of development, and the mycelial filaments can be seen to be coarser and septate. On one hand may be seen a well formed though unripe fruit stalk and head (Fig. 3, B), while in the center of the field there may be seen the ripe aerial fruit, from which the fully grown spores drop, literally in myriads. (Fig. 3, C.)

The characteristic difference between the two varieties of aspergillus, the so-called *yellow* and *black*, is seen in the shape

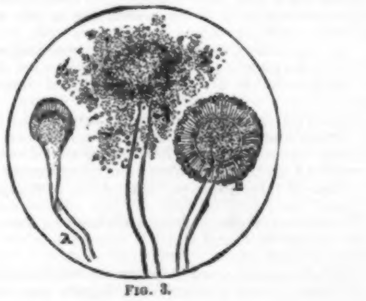


FIG. 3.

and size of the *receptaculum*, and the arrangement of the *sterigmata* upon it, these two parts forming the so-called "head" or *sporangium.*

In the *A. nigricans* (Fig. 3, B) the sporangia or heads are distinguished from those of the *A. glaucus* (Fig. 3, A.) by the fact that in the first the sterigmata cover the receptaculum, which is spherical, on all sides, while in the latter, the lower fifth or fourth of the receptaculum, which is ovoid in shape, is entirely free from sporangia.

Of the latter variety I have seen but one specimen, which, however, I did not remove from the ear. It was given to me by my friend and instructor in Heidelberg, Prof. Moos, who had removed it from the ear of one of his patients. The specimen I mounted in glycerine in the winter, 1870–71, and still retain it in the same perfection in which I received it. Although there is some oleaginous matter in which the fungus was found in the ear, still adherent to the specimen, there is no evidence of germination; yet it has been thought by Wreden that, in one instance in which aspergillus from the ear had been preserved in glycerine, germination went on to some extent. In no instance have there ever been, in cases observed by me, any evidences of continued growth of this fungus after it had been placed in glycerine for preservation. But small portions of the myce-

lial web or of the fungous mass as it comes from the ear, will, if placed in a glass box, continue to grow and to retain the microscopic appearance of *Aspergillus nigricans*.

From the fact of this retention of form, it would seem that this is a specific fungus, and not ordinary mould modified by growing in the ear.

It may be said, then, that in general there are found with the aid of the microscope, four distinct elements in a fungous mass of aspergillus taken from the human ear, viz.:

1. The mycelial web, composed of the so-called tubules, rootlets, or filaments.
2. The fruit stalk or hyphen, and
3. Its head or the sporangium.
4. The free spores.

The first, the filaments or tubular rootlets, are composed of sections, and are hence described as septate. The component cellules are from 0·020 mm. to 0·030 mm. in length.

The fertile hyphens or fruit stalks vary in diameter from 0·009 mm. to 0·013 mm., and their length is 0·770 mm. These terminate in the so-called *receptaculum*, the placenta of Micheli, which has a diameter of 0·028 mm. (Robin.) On this grow the sterigmata and spores, the three together forming the so-called capital or head, 0·060 mm. in diameter, the third of the elements named above.

The spores are spherical and measure 0·003 mm. in diameter. By careful fine adjustment of the lens, their surface is seen to be echinate. Some idea of the immense number of these spores in any case may be gained by Paccini's estimate, quoted by Robin, that there are *nineteen thousand* spores on each fruit head.

Macroscopic features.—The macroscopic appearances of a mass of this fungus, as found in or washed from the ear, are worthy of attention. For, although the microscope must in every case decide the presence of aspergillus in a suspicious object coming from the external auditory canal, nevertheless the microscopic features of a plug or membrane composed of this aural fungus are of a nature to lead the surgeon to suspect that he has to deal with a case of aspergillus in the ear. If an ear containing a mass of aspergillus be examined by means of an ear mirror and ear funnel, it will present most usually an appearance which leads to the supposition that the ear is occluded not by wax, but by a foreign matter of an organic nature.

If the fungus has not been growing long in the ear, merely a patch of pale yellow, pollen like matter, of varying diameters, will be detected at the fundus of the auditory canal. This small colony of spores just developing into filaments, for such it is, is usually situate on the membrana tympani or very near it. In any case, whether the first deposition of spores occurs there or not, the tendency of the aspergillus is to grow over the drum head first, and from that point it spreads outward, covering the wall of the meatus, until a hollow cast of the canal is formed by the vegetable parasite. The pollen-like appearance is seen only in the very earliest stages of a growth of that which is finally a so-called lardaceous looking or false membrane, either partially or entirely filling the external auditory canal.

In some cases the fungous mass looks like a ball or plug of wet newspaper, and in others the ear may seem to be plugged with a substance looking like wool. An inexperienced eye might conclude that the occluding plug thus formed is of ear wax; but ear wax looks more solid, shining, and drier, and it never excites pain and inflammation in the ear like the fungus aspergillus.

Another important point in differential diagnosis is that a mass of aspergillus does not lose its coherence when subjected to immersion in water or glycerine; but a lump of ordinary hardened cerumen soon melts, and is diffused throughout the water or any other fluid in which it is allowed to lie.

Finally the microscope would immediately show whether such a mass washed from the ear were aspergillus, or the peculiar laminated, epithelial plug, the so-called *Keratosis obturans* of Wreden.

[We omit the recital of the cases, a large number of which are given by the author].

GENERAL REMARKS.

Symptoms.—The symptoms of the growth of this parasitic fungus in the external ear may be briefly given as stinging, itching, with dullness of hearing, some pain, and a watery but scanty discharge. The patient may finally complain of great pain and deafness, if the membrana tympani should become inflamed.

An ear thus affected will show on examination, the presence in it of a grayish, sometimes mottled, flaky mass, or if examined in the earliest stages of disease, it reveals the presence of a false membrane neatly adapted to the membrana tympani and the inner part of the auditory canal. From this point the false membrane may—sometimes does—extend along the canal until it projects from the orifice at the concha of the auricle. When seen in its early stages of growth, the false membrane over the drum head looks dry and downy, and somewhat shining; later it looks crumpled, and resembles a piece of wet newspaper. Any free edge of the membrane visible will appear much thicker than flakes of epithelium. Once seen, this parasitic membrane is easily recognized again. The diagnostic features of such a false membrane or fungous mass may be learned from what has already been said under the head of *Macroscopic Appearances*.

If any doubt should exist about the presence of aspergillus in the ear it is usually dissipated in a day or two, on the return of the patient, for unless the treatment has been the proper one and very successful, the false membrane will have formed again. This, of course, removes all doubts, and should prompt us to great activity and watchfulness, or we shall have a stubborn disease to combat.

The microscope will remove all doubts as to the nature of any suspicious looking flake or lump removed from the ear.

Etiology.—It must be evident to the reader of the details of the twenty cases here presented, that this disease is not confined to those living in poverty and squalor. In fact my experience is the reverse of this. Only three cases could be said to have occurred in the poor and unclean. As long as the secretion of ear wax is unimpeded and, when secreted, if the cerumen is not scraped away, no one is likely to be affected by aspergillus in the ear. If the ceruminous secretion is disturbed in any way, especially if now the skin of the auditory canal be abraded, anybody may be, probably will be, attacked by this parasite. The chief causes of the growth of this parasitic fungus in the ear, I find to be undue picking and scratching of the ear, and dropping in and leaving there oils and fats of various kinds and pieces of vegetable matter. These becoming rancid or putrescent, a fitting soil for the aspergillus is given.

Next to these causes is the neglect to wash the ear after it has been the seat of boils or any inflammation, which may leave behind it small particles of pus, serum, blood, etc. It is needless to say that all of the latter, when putrid, may become the nidus of a colony of aspergillus.

If the patient should be living in damp apartments, of course this must be ended, if possible, either by cleansing and drying his dwelling, or by removal from this probable source of disease. If any other excitant can be shown to be the probable cause of the growth of the fungus in the ear, of course it must be removed if possible.

I must repeat here what I have written elsewhere concerning the protective function of cerumen. There is no evidence that the aspergillus grows on the natural ceruminous secretion of the auditory canal. It appears, indeed, that but for the presence of the cerumen in the canal, the ear might be invaded more frequently by the aspergillus, since the latter seeks a secluded spot for growing. The protection of the cerumen in this particular is shown in the fact that in an ear, the canal of which is sheathed with ear wax, aspergillus is rarely found at all, and never in a flourishing condition, while in an ear invaded by aspergillus, cerumen is rarely, if ever, found in a normal quantity or condition.

On this point of contagion I am very careful, for it would be very easy to convey aspergillus from one person to another, not only by the syringe, but by specula, cotton holders, etc.

Treatment.—The treatment of aspergillus in the ear consists in killing and removing all parts of the plant, and especially all its germs. The syringe is the best means of removing the parasite, after it forms into false membrane, but if the latter be adherent, other mechanical means may be necessary. Hence I find it useful, if the fungous membrane has reached any size, or if it be visible as whitish flakes or spots, to wipe these traces of it away from or off the walls and membrana tympani, by means of the cotton dossil on the cotton holder. This is easily done and causes no pain to the patient. If these patches should be very adherent, they must not be forcibly removed. They are to be loosened then either by time or by the use of a parasiticide. Experience shows me that these false membranes are not usually adherent but easily detached. I have never employed but two parasiticides, viz., alcohol, usually pure, but sometimes in various proportions with water, rarely weaker than one of the former to two of the latter, and hyposulphite of soda.

My solitary experience with hyposulphite of soda, three grains to the fluid ounce of water, leads me to place it next to alcohol, as a destroyer of the aspergillus. In the future I propose to use it more frequently than in the past. I have found it of advantage to let the patient use the drops which are to destroy the parasite, without subsequent syringing on his part. Of course this omission of syringing on the patient's part can only be permitted when he can be seen by an aurist daily. The greatest gentleness is requisite in all cases of aspergillus in the ear, lest eczema be excited, since in all these cases the ear seems to possess a readiness to slip into the eczematous state.

Of course, should this complication arise in the parasitic disease, it must be combated on general principles. If possible, all fatty matter should be excluded from the treatment of eczema in these cases, since oleaginous substances feed the fungus.*

In conclusion, it may be said the ear thus diseased should be carefully examined by means of the ear mirror and speculum every day, and the treatment modified according to the stages of the disease. The least irritation of the ear, combined with the most efficient destruction and mechanical removal of the parasite, will give the most satisfaction to both surgeon and patient.

DETERMINATION OF POTASSA AND SODA IN MINERALS.

By W. KNOP and J. HAZARD.

THE authors dissolve in hydrofluoric acid, evaporate, drench the residue with concentrated sulphuric acid, thus removing the bulk of the silica as silicon fluoride. The sulphuric acid is then evaporated off, the dry residue moistened with five or six drops of concentrated sulphuric acid, heated, drenched with 150 c.c. water, and barium hydrate added till red litmus paper is turned distinctly blue. The mixture of barium sulphate, silica, alumina, magnesia, and ferric oxide is then filtered off and well washed. The filtrate is evaporated to dryness, adding, when it is concentrated down to about 200 c.c., a few grammes of dry ammonium sesquicarbonate. When perfectly dry the residue of barium and calcium carbonate is extracted successively fifteen times, each time with 20 c.c. water, the liquid being each time filtered through a small filter of 3 to 4 c.m. diameter into a platinum capsule, and evaporated to dryness. The residue is drenched again with 20 c.c. water, the water is decanted through a similar fresh filter, and the solution—after it has deposited a little barium carbonate with some alumina and iron, is collected along with the washings in a fresh platinum capsule. The alkaline carbonate, to which a few more granules of ammonium carbonate have been added, is again dissolved in 20 c.c. water, observing that no residue remains. The liquid is then neutralized with hydrochloric acid, evaporated, the chlorides dried strongly, and the potassium and sodium separated by means of platinum chloride.—*Chem. Central Blatt.*

FERRIC HYDRATES.

By DR. D. TOMMASI.

IT appears that all these hydrates may be arranged in two series, respectively isomeric, the red and the yellow. The former are obtained by precipitating a ferric salt by potassa, soda, or ammonia. When calcined they present the phenomenon of incandescence; they dissolve readily, even in the weakest acids. Ferric chloride dissolves them in quantity, and the solution gives a precipitate of ferric hydrate on the addition of potassium sulphate or sulphuric acid. They are dehydrated on boiling with water. The yellow hydrates are obtained by oxidizing ferrous hydrate or carbonate, or magnetic hydrate. If these hydrates are calcined they do not display incandescence; they are sparingly soluble in acids, whether dilute or concentrated; they are not attacked by ferric chloride; if boiled in water they only lose two molecules of water, retaining the third, even if boiled in a concentrated solution of calcium chloride. It is possible that not merely the ferric salts, but also the compounds of chrome and aluminum, may exist in these two modifications. If the two ferric chlorides are treated with silver nitrate, the one precipitates all its chlorine, whilst the other gives up four atoms at first and the two others afterwards. In a similar manner the blue chromium chloride gives up all its chlorine at once, whilst the green chloride gives up two thirds at first and the remainder afterwards. There ought to exist two ferric sulphates corresponding to the two chromic sulphates. The two latter are distinguished not merely by their color, but by the fact that the blue sulphate gives up all its acid to baryta, while the green sulphate retains a part.

* The investigations of Bezold, of Munich, have fully confirmed the fact that the use of oleaginous matters for the cure of ear diseases is very often the cause of the growth of aspergillus in the ear.

ACTIVE MATTER OF MALT, OR MALTIN AND DIASTASE.

By M. DUBRUNFAUT.

THE author ascribes the following properties to the diastase of Payen. It exists in malt to the extent of one to two-thousandths; it liquefies 2,000 times its weight of starch; it is free from nitrogen, and saccharifies 2,000 times its weight of starch (according to Guerin only 15 times). It has no rotatory power; is soluble in weak alcohol, but insoluble in anhydrous alcohol, and not affected by this liquid. It is not altered on solution in water at 75°, but is modified at 100°. Its maximum of activity is at 75°. Maltin, on the other hand, exists in malt to the extent of one part in 100; it liquefies 200,000 times its weight of starch; it contains from 0·07 to 0·08 of nitrogen, saccharifies 100 times weight of starch, and possesses a strong lævo-rotatory power; it dissolves in alcohol at 40 to 50 per cent., but is insoluble in, though modified by, strong alcohol. Its maximum activity is below 50°, and it exists not merely in cereals, but in many potable waters.

TEST FOR TRACES OF MERCURY.

By ED. TEUBER.

THE material, dry and finely powdered, is mixed with well ignited iron filings and a little red lead. The mixture is placed in a crucible upon a layer of red lead and covered with a layer of iron filings. The lid of the crucible is so arranged that all the fumes given off on heating the capsule must impinge upon the bottom of a small gold capsule filled with cold water. Traces of mercury down to 0·0001 grm. may thus be detected.—*Oest. Zeitschrift Berg und Huttenw.*

[COUNTRY GENTLEMAN.]

HORTICULTURAL NOTES.

CURL IN THE PEACH.

PROF. BURRILL, of Illinois, has recently made a thorough examination of the minute fungus which had long since been known to cause the curl in the leaf of the peach, and states that the name appropriately given to this fungus is *Ascomyces deformans*. He has traced this fungus to the unopened buds. As the leaf expands it is carried along, and finally produces the well-known deformity. The young bark of a diseased twig is filled with the threads of the fungus, and is sometimes distorted with ridges and swellings and blister-like excrescences. Prof. B. therefore recommends the pruning away in winter of such twigs as may be found to be thus diseased, and committing them to the fire. To this we would add the importance of keeping the trees in a vigorous state of growth, as feeble ones recover less rapidly. The appearance of the curl is usually most conspicuous after a cold snap just after the leaves are expanded, this condition of the weather favoring the development of the fungus, just as certain kinds of weather in summer develop the rust in wheat, the young rust plants existing previously within the stalks.

LATE PEACHES.

The importance of a continuous supply of peaches through the entire season of the year, while they may be had, is obvious to every one; and now that several very early varieties have been raised, we may have, with a little care, plenty of ripe ones every day from the end of July till hard freezing in autumn, in latitude as far north as Rochester. Much inquiry has been made for good late sorts. M. B. Bateham, of Northern Ohio, secretary of the State Horticultural Society, gives, as the result of much observation, the following names: The Smock, quite reliable in Northern Ohio, has been widely planted there, and, we may add, ripens well in New York in warm seasons. After the Late Crawford has gone, and before the ripening of the Smock, he recommends Hill's Chili, which is a few days later than Crawford's Late. This variety originated in Western New York, but appears to succeed better in Ohio and Michigan. Next after Hill's Chili he names the Brandywine of New Jersey, which slightly precedes Smock, while it exceeds it in size and fine appearance. The Salway follows the Smock, and does well a little farther south.

EARLY FREESTONE PEACH.

Nearly all the very early varieties which have been brought before the public within a few years are alike in a strong adhesion of the melting flesh to the stone; and one in which the flesh separates freely from the stone has been sought. The *Canadian Horticulturist* describes a new sort, known as the Early Canada, in which this desirable characteristic is quite distinct. The fruit ripens about the first of August, possibly a little after the Amsden, and it is described as of fair size (rather indefinite), bright in color, of excellent quality, and nearly a perfect freestone. It is certainly worthy of trial.

GOOD CULTURE OF AN ORCHARD.

Charles A. Green, of Ontario county, N. Y., furnishes the *Rural Home* a statement of his excellent management. He had an apple orchard which had been in sod many years. In the autumn of 1878 he plowed it quite shallow, and gave a thorough cultivation with a two-horse cultivator the following spring and early in the summer. The fruit the past season was larger and finer in appearance, and, what is still more important, was less injured by the codling worm. No attempt was made to plow close to the trees, as not being necessary, and avoiding injury to the bark. The quick grass and thistles in the orchard were nearly extirpated by the treatment thus given. Mr. G. remarks: "Old apple trees exhibit marvelous vitality under proper treatment, and may be made attractive in appearance by pruning." To which we may add, that we have known trees, so old that nearly half their branches or shoots were dead when standing neglected in grass, restored to great productiveness by cutting out dead and feeble limbs, and treating with a wide and copious top-dressing of manure.

HOW TO GROW TUBEROSES.

MR. G. HOWATT, Placerville, Cal., having grown tuberoses by the acre from offsets, and forced them extensively in greenhouses and pots, his opinion as to the best treatment of this charming but capricious member of Flora's family may be accepted as of value. To begin with, a bulb as large as a nutmeg or smaller, is as likely to flower as one the size of a Bartlett pear, and he has seen spikes bearing forty or fifty blossoms. In the second place, a bulb that has once flowered will not flower again. But at its base after it is taken up in the fall will be found several offsets or baby bulbs, which is nature's provision for perpetuating the stock. Let these remain with the parent, and store for winter in a dry temperature, not below 60 degrees. In spring, after danger from frost is well past, remove the offsets and plant in good warm soil (yellow loam preferred, enriched with decomposed cow manure) after the following plan, which we copy from the *California Horticulturist* in Mr. Howatt's own words:

Have a marker with pegs set twelve inches apart; stretch a line tightly, and draw one peg along your line; then the successive rows will be straight. Use a spade and cut down perpendicularly by each mark, so as to plant the offsets six inches deep, and about the same distance apart. Being so slow to start, you may drop a few radish seeds along the row, which will mark it nicely, and furnish radishes for the table before they are in the way of the tuberoses. For planting in this bed, select the smallest offshoots you can, for if large they will probably flower before the season is over, and the object is to produce good large flowering bulbs for the next year's blooming. But if any show signs of blooming they can be dug about, lifted carefully, and put in a pot, where they will expand the whole spike of flowers without trouble.

The treatment of the bulbs after they have attained sufficient size for flowering is thus given:

The offsets are ready for bloom after one year's growth, as above described. In lifting from the bed the large bulbs which are to bloom next year, throw them in heaps, cut off the leaves, and put in a dry place; if in the greenhouse, let it be near your heating pipes. For early flowering, in January we put three bulbs in an eight-inch pot. Put them in the warmest place you have, behind the stove if possible. They will stand 100° Fahr. Keep the soil dryish until the green leaves start. Then use all the water they want and they will come on rapidly. Plant outdoors when it becomes warm, for late autumn flowering. Start some in July and August for flowering at Christmas or New Year's. The later ones planted will not need much care, although a little bottom heat will assist in starting them at any season.

THE GREAT GLACIER OF EASTERN AMERICA.

PROF. J. G. SMOCK, Assistant State Geologist of New Jersey, read a paper of general interest, at the late session of the American Association, upon the limits and thickness of the continental glaciation in that State. It referred to the existence of a "great terminal moraine," which has been described in several of the State geological maps. It runs from near Amboy to Plainfield, thence to Morristown, and thence almost due north almost exactly along the line of the Delaware, Lackawanna, and Western Railroad, to and beyond the water gap. This line of elevations rises on the eastern coast to a height of 100 or 5,000 feet, but westward the hills rise much higher.

[From the *Monitor Sul Mineiro.*]

A REMARKABLE CAVE IN BRAZIL.

MESSRS. PASSIGS, the photographers now in Campanha, have kindly furnished us with a long description of a wonderful cave in this province, known as the *Caverna da Rifina*. It is in the Serra da Canastra, nine kilometers from the village of Sacramento and three from the Jaguara bridge road. Messrs. Passigs had learned that one Snr. Figueiredo and several other persons had already been in this cave, and discovered four or five vast halls. A natural desire to explore this cave led the brothers Passigs to visit it on the 5th of March last, in company with Snr. Figueiredo, mentioned above, and one servant. Others were prevented from joining the party by the rain or by a lack of the necessary courage.

At two o'clock they reached the majestic entrance of the cave and entered the first enormous hall on horseback. This hall was calculated to be from fifty to sixty meters high and from one hundred and fifty to one hundred and sixty meters wide, narrowing toward the interior, where it was only about eighty meters wide. All this hall was lighted from without. Its walls are of freestone, except the lower part, which is of sandstone. Along one side runs a small stream of crystalline, though quite brackish water, coming from within. At the bottom of this hall is a narrow corridor, into which the explorers penetrated, each one carrying a couple of candles and marking the narrow winding passages with grains of corn. It was necessary to leave behind hats, coats, and vests, and even so it was only with difficulty that some places could be passed by crawling along the ground. In the third hall were swarms of bats, which frequently struck against the explorers. Examining the ground for indications of dangerous animals, nothing more was found than the tracks of the paca. This chamber was not more than five meters high by twelve wide. From here they passed through a corridor about twenty meters long by three high, at the end of which there was a small stream of water. There were several outlets in the sides of this corridor opening into lateral halls, of which only three were examined. To this point this cave had already been explored by other parties, and among them some ladies, who had left their names upon the walls. From here on the passage became more difficult and even dangerous, and the farthest points were reached only by crawling flat upon the ground. The explorers did not lack the necessary courage, and after dragging themselves along for a great distance, weary and bruised, they reached an immense cavern. The walls of this great hall were white, and so far apart that one could not see across with the aid of eight candles. The sounds of a waterfall reached the ear, but the fall could not be found. This dome-shaped hall, calculated to be about two hundred meters in diameter and over one hundred and fifty meters high, presented a picture of extraordinary beauty. The walls appeared to have been made by the hands of a skillful artist, while from the center there arose a wonderful cupola and an immense pillar which seemed to support the vault of this great hall. On one side the little stream came in sight again, with its bed lined with beautiful crystals. Communications between this hall and other parts of the cave were made through numerous corridors and orifices. Many other chambers of more or less importance were visited, and among them one about one hundred meters long by ten high and five wide, in the middle of which was a pillar of stones so regularly placed one upon upon another as to look like the work of man. Besides many other halls, one corridor was found nearly two meters wide, three high, and ten long, which at its entrance resembled the English church in São Paulo.

The explorers think they saw more than sixty halls and corridors in a distance of perhaps three kilometers. The farthest point reached is not the end of the cave, but as they did not know the hour, and fearing that their prolonged absence might alarm their companions who were waiting outside, they returned, reaching the outer hall at 7 o'clock.—*Rio News.*

PLIOCENE MAN.

By DR. CHARLES C. ABBOTT.

WITHOUT doubt, the memoir by Professor Whitney is the most valuable and interesting contribution yet made to the subject of prehistoric archæology. Not only has the topic great interest in itself, but this phase of it has an additional interest, because a portion of the evidence he brings forward has been subjected to much adverse criticism, not only by men of some scientific attainments, but by the popular secular, and the biased religious papers of the day. The author, however, effectually disposes of all objections, as we think, and clearly demonstrates the correctness of the conclusions he drew years ago. While being occasionally hinted at in various ways, these conclusions have never been published *in extenso* until the appearance of the present volume.

We shall give in briefest outline the character of the evidence which Prof. Whitney here produces; it does not stand alone, but supplements and, we believe, confirms the indications of Tertiary man, both of Europe and Eastern North America. In his introduction the author remarks that "gradually the evidence has accumulated from widely separated regions, until the idea of prehistoric man has become familiar to geologists." He then asks, "How far back can man and his works be traced?" The memoir supplies an answer to this question so far as it relates to California. Any one who has spent days and weeks in searching for fossils or stone implements in gravel deposits, can testify how discouraging such work is. Millions of pebbles are to be glanced at and overturned, and often there is nothing but millions more to look at, when the surface of a bluff has been removed. In California, where the hydraulic method of attacking the gravel deposits is almost wholly employed, there is still less chance in finding objects of interest than there was in the older method of tunneling. Whether of bone or stone, traces of man subjected to violent displacement by streams of water are pretty sure to be destroyed or again buried by the rapid overturning of the gravel beds.

Much of the material on which Prof. Whitney bases his paper has been collected by Mr. C. D. Voy, and is now in the museum of the University of California. This material has been gathered principally from Mariposa, Merced, Stanislaus, Tuolumne, and Calaveras counties. In Mariposa county, stone implements and mastodon remains have been found intimately associated, at a depth of twelve feet. Much of like nature has been found in the two counties next referred to, while Tuolumne county is particularly mentioned as a region more prolific in human remains and prehistoric works of art than any other in California. This evidence of early man has been very carefully sifted by Prof. Whitney, and it appears that the fact of the remains being really found in such positions as to indicate great antiquity is fully demonstrated.

Calaveras county is more fully treated of, as the evidence is of somewhat different character, and has given rise to much discussion. "We now come," says Professor Whitney, "to a county where occurrences of human remains do not seem to have been as frequent as they were in the adjacent Tuolumne, but where one specimen has been obtained which has excited more interest than all the others put together, and which is popularly believed to be the only instance of the kind which has been met with in California. A perusal of the following pages will, however, it is thought, satisfy the reader that the belief of the existence of man in that region previous to the cessation of volcanic activity there, is not by any means supported by one item of evidence alone." The history of this "one item," the now celebrated Calaveras skull, is then given in minute detail. Suffice it here to state that it was found at a depth of 132 feet, and exhibits many peculiarities which tally with the statements of the finder, and are conditions which could only exist in a cranium found as this specimen is said to have been. This alone, as is most ably demonstrated by Prof. Whitney, should satisfy any one disposed to question the truthfulness of the statements made by the gentleman who found the specimen. Were nothing else ever to be found, there is in this Calaveras skull, as we believe, all that is necessary to demonstrate the existence of Pliocene man in California; but Amador, El Dorado, Placer, Nevada, and Butte counties have all yielded corroborative evidence. As Professor Whitney remarks, "the passage from Pliocene through Post-Pliocene, if such a division can hereafter be maintained in this region, has been a gradual one, and some of the Pliocene animals have certainly lived close up to the recent period. That a portion of the human remains and implements described in the preceding pages are as old at least as Pliocene, it seems hardly possible to doubt.

"The discoveries in California, India, and elsewhere seem clearly to indicate that the human race must have existed, over a large portion of the world at least, for an immense period of time in the primitive condition, that is, at the lowest possible stage of humanity—civilization it cannot be called. So far as California is concerned, the evidence all points in this direction. The implements, tools, and works of art obtained are throughout in harmony with each other, all being the simplest and least artistic of which it is possible to conceive. Whether found in the strata under the basaltic lava, or above, at any point in the detritus, we always recognize the same type."

The conclusions of Prof. Whitney's volume are as follows:

"*Finally*, as the summing up of the discoveries and investigations made by the Geological Survey in California, we have:

"1. The clear and unequivocal proof, beyond any possibility of doubt or cavil, of the contemporary existence of man with the mastodon, fossil elephant, and other extinct species, at a very remote epoch as compared with anything recorded in history.

"2. That man, thus proved to be contemporary with a group of animals now extinct, did not essentially differ from what he now is in the same region, and over the whole North American Continent.

"3. That there is a large body of evidence, the strength of which it is impossible to deny, which seems to prove that man existed in California previous to the cessation of volcanic activity in the Sierra Nevada, to the epoch of the greatest extension of the glaciers in that region, and to the erosion of the present river cañons and valleys, at a time when the animal and vegetable creations differed entirely from what they now are, and when the topograpical features of the State were extremely unlike those exhibited by the present surface.

"4. That man existing at even that very remote epoch, which goes back at least to the Pliocene, was still the same as we now find him to be in that region, and the same that he was in the intermediate period after the cessation of volcanic activity, and while erosion of the present river cañons was going on.

"5. That the discoveries in California, and those in other parts of the world, notably in Portugal and India, present a strong body of evidence going to prove the existence, during an immensely long period, of the human race in its primitive condition—that is to say, in the simplest and rudest condition in which man could exist and be man.

"6. That so far as we know, there is no evidence of the existence of any primordial stock from which man may have been derived, so far back at least as the Pliocene. Man, thus far, is nothing but man, whether found in Pliocene, Post-Pliocene, or recent formations."

That some of these conclusions, here so positively stated, may be modified by future discoveries, is highly probable. Especially as to the discovery of some "primordial stock," do we think this to be the case. That such stock once existed is necessarily true; that all trace of it has vanished is improbable; and not earlier than the dawn of the Pliocene is it necessarily needful that one should go to seek for such traces. The Pliocene epoch was not a matter of a few years, and what the formations of that age, in other continents, may contain that shall throw light on man's origin, have yet to be gathered. When the Pliocene strata of Africa and Asia have been carefully examined, and they are found to contain no traces of man more primitive than those of California and elsewhere, then it will be proper to expect that such traces will be found in the Miocene. That unquestionable traces of the missing link are now resting in some tertiary deposits, we have not the shadow of a doubt.—*Science News.*

GEODES.

THE region where geodes are to be found in their greatest abundance is along the Mississippi and its immediate branches, covering a space of over a hundred miles in length. Owing to their limited extent, they are not common to the public.

To justly estimate their importance in the make up of the earth, let us acquaint ourselves with their history. Geodes, or hollow pebbles, vary in size from that of a marble to many hundreds of pounds in weight. They belong to the Azoic age, the term here used implying absence of life or at least that of animal existence.

Geodes are found in limestone regions, and are of igneous origin; that is, they were produced by the action of fire. To demonstrate the fact a mass of mineral substance was melted. Crystals, it must be noticed, are the result of heat, and their form is assumed in the process of solidification. Granite shows imperfect crystals, but the interior of a geode displays them in perfect form and dazzling beauty. A single geode may contain hexagonal prisms, pentagon crystals, and sometimes a space is filled with feldspar. The general form of the geode crystal is pentagon, that is, having five sides. The clear, glass-like crystal is the purest and most solid. Its number is seven in the scale of hardness, and it will readily scratch glass. To the person who is interested in the beauties and wonders of nature, geodes are particularly interesting, because of their form and especially their handsome crystals. Other matter aside of crystals may constitute the interior of a geode. One we found on Fox river contained solid spar impregnated with other mineral that gave it a black, refulgent appearance, and added also greatly to its weight. In other localities we have found specimens like the one described. They are very beautiful and rare. Calc spar, of less hardness than crystals, often compose the greater part of a geode. Others may be solid, the crystal not having room to develop into regular forms. Nearly all geodes contain some golden colored crystals. This is due to the infiltration of water containing mineral substances.

The most abundant mine of geodes in this country is perhaps the one on Fox river near the Moore crossing; although other places along the river afford plenty of these articles. At the first mentioned place the river bluff is high, and from the water up the bank to the height of ten or fifteen feet the chief rock is limestone. This, and the alternate layers of clay, are thickly studded with geodes of the smallest and largest sizes. Some specimens over two feet in thickness have been taken from this place. The writer has in his geological collection two specimens of geodes that are truly gems of beauty. They are not second to any that the mine has yielded. Different places afford different kinds of geodes. Thus, on Fox river the geodes show large crystals—then spar in abundance; while over in Lee county the geodes often show distinct forms to those of our county. Spar appears to be more plentiful in the geodes of Iowa than with ours. Some persons have been engaged in collecting and shipping geodes to Eastern cities, where they were seized with a relish by museums and collectors of curiosities. It is said that a certain man made several thousand dollars by collecting and shipping geodes from a little tributary of the Mississippi just above Keokuk.

The limestone bluffs of Warsaw, Keokuk, and other points are noted for their abundance of geodes. Beautiful pyramids and mounds suitable for yard and house ornaments may be formed by the proper placing of geode fragments.

Geologists care nothing for the beautiful interior of a geode. It is the outside that interests them, for it is thus that a geologic age may be determined.

The writer has sent specimens of geodes to persons in nearly all the states and they have always been received with pleasure and delight.

While the fields produce fragrant flowers, the hill sides and river beds possess beauties no less attractive than the botanical blooms that charm us. Search with willing hands for the geological flowers of crystals, crinoids, ores, and fossil remains. Learn to distinguish stratified from unstratified, and aqueous from igneous rocks. From the grains of sand to the valued ores, learn something. Be observing. Notice our parallel strata of rock, and when in other places perceive that stratified rocks may be inclined or dipped. Study the formations of the earth. And don't forget that the most common relic may be the most interesting.—*Alexandria (Mo.) Commercial.*

The Scientific American Supplement. Index for Vol. 8.

JULY—DECEMBER 1879.

The * indicates that the Article is illustrated by Engravings.

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